SB4255E01
Jan. 2008

Vehicle System

Specification
System Operation
Testing & Adjusting

D20S-5, D25S-5, D30S-5, D33S-5, D35C-5
G20E-5, G25E-5, G30E-5
GC20E-5, GC25E-5, GC30E-5, GC33E-5
G20P-5, G25P-5, G30P-5, G33P-5, G35C-5
GC20P-5, GC25P-5, GC30P-5, GC33P-5

Important Safety Information

Most accidents involving product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards. This person should also have the necessary training, skills and tools to perform these functions properly.

Read and understand all safety precautions and warnings before operating or performing lubrication, maintenance and repair on this product.

Basic safety precautions are listed in the “Safety” section of the Service or Technical Manual. Additional safety precautions are listed in the “Safety” section of the owner/operation/maintenance publication.
Specific safety warnings for all these publications are provided in the description of operations where hazards exist. WARNING labels have also been put on the product to provide instructions and to identify specific hazards. If these hazard warnings are not heeded, bodily injury or death could occur to you or other persons. Warnings in this publication and on the product labels are identified by the following symbol.

⚠ WARNING

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.
Do not operate or perform any lubrication, maintenance or repair on this product, until you have read and understood the operation, lubrication, maintenance and repair information.

Operations that may cause product damage are identified by NOTICE labels on the product and in this publication.

DOOSAN cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are therefore not all inclusive. If a tool, procedure, work method or operating technique not specifically recommended by DOOSAN is used, you must satisfy yourself that it is safe for you and others. You should also ensure that the product will not be damaged or made unsafe by the operation, lubrication, maintenance or repair procedures you choose.

The information, specifications, and illustrations in this publication are on the basis of information available at the time it was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service given to the product. Obtain the complete and most current information before starting any job. DOOSAN dealers have the most current information available.

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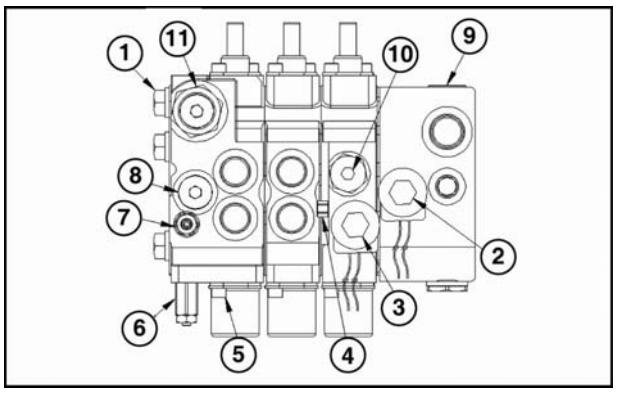
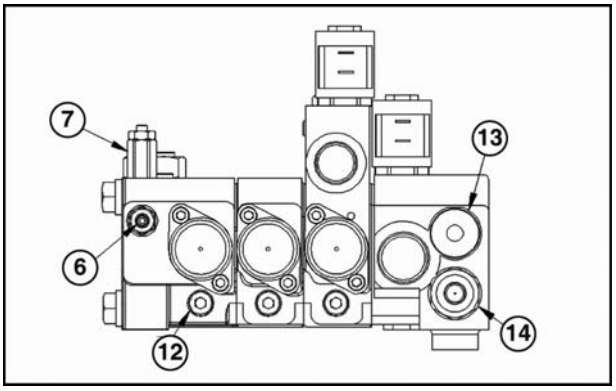
Specification

Hydraulic Control Valve

CONTROL VALVE		
	Main Relief Pressure	Tilt, Auxiliary Relief Pressure
D20S-5 G20E-5 G20P-5 GC20E-5 GC20P-5	18,100 ± 350 Kpa 2,625 ± 50 psi	15,500 ± 350 Kpa 2,250 ± 50 psi
D25S-5 G25E-5 G25P-5 GC25E-5 GC25P-5	19,500 ± 350 Kpa 2,825 ± 50 psi	15,500 ± 350 Kpa 2,250 ± 50 psi
D30S-5 G30E-5 G30P-5 GC30E-5 GC30P5 G32E-5 G32P-5	21,550 ± 350 Kpa 3,125 ± 50 psi	15,500 ± 350 Kpa 2,250 ± 50 psi
D33SC-5 D35SC-5 G33P-5 G35P-5	24,000 (+500,0) Kpa 3,490 +75,-0 psi	15,500 ± 350 Kpa 2,250 ± 50 psi





(1) Torque for bolts that hold control valve sections Together .....40.5±2.5 N·m (360±24 lb·in)

(2) Torque for nut..... 4.9±0.5 N·m (43±12 lb·in)

(3) Torque for nut..... 4.9±0.5 N·m (43±12 lb·in)

(4) Torque for plug..... 1±0.5 N·m (9±5 lb·in)

(5) Torque for screws... 5.4±2.7 N·m (48±24 lb·in)

(6) Adjust main relief valve pressure for lift as shown above. See Relief Valve Pressure Check in Testing And Adjusting.

(7) Adjust secondary relief valve pressure for tilt and side shift as shown above. See Relief Valve Pressure Check in Testing And Adjusting.

(8) Torque for plug.....5.5±2.5 N·m (492±24 lb·in)

(9) Torque for plug....63.7±2.5 N·m (564±24 lb·in)

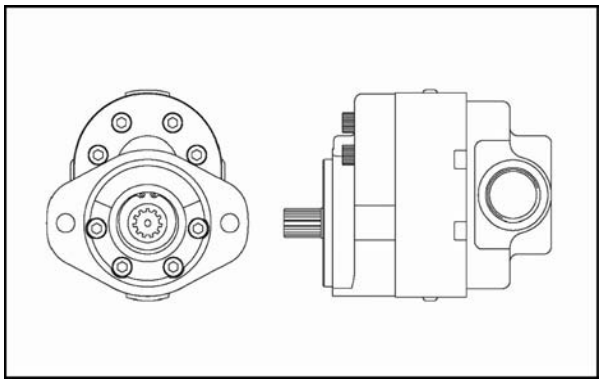
(10) Torque for plug.....55.5±2.5 N·m (492±24 lb·in)

(11) Torque for plug.....30±2.5 N·m (260±24 lb·in)

(12) Adjust tilt and side shift flow rate by using 6mm hex-wrench if required. See Flow Control Valve Adjustment in Testing And Adjusting.

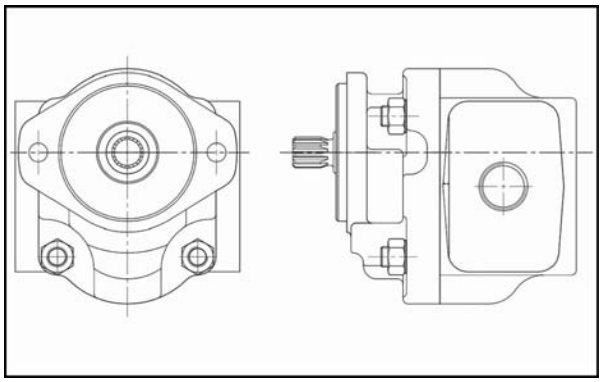
(13) Torque for plug..... 63.7±2.5 N·m (564±24 lb·in)

Hydraulic Pump



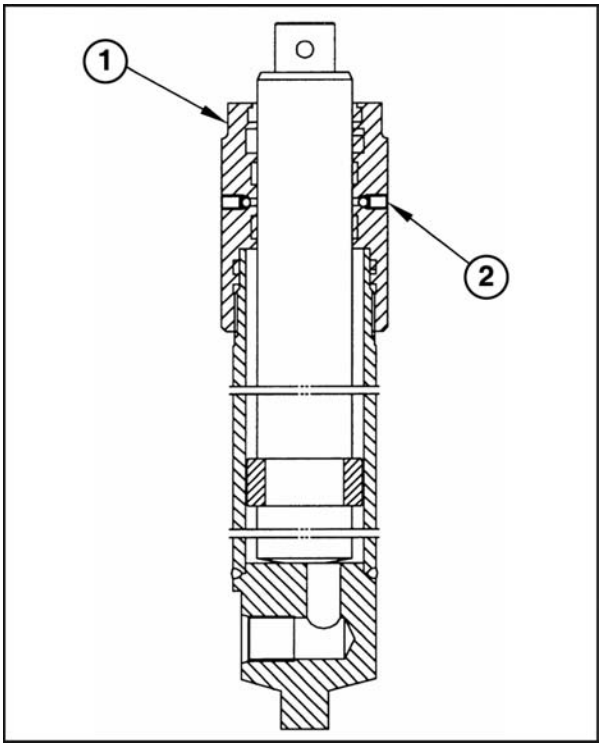
Type of pump : gear
Displacement
D518161 : 30.6 cc/rev for D20/25/30S-5 (Tier-Ⅱ)
D518162 : 27.7cc/rev for G20/25/30(E)P-5 &
GC20/25/30/32(E)P-5
D20/25/30S-5(Tier-Ⅲ)
D514185 : 29.0cc/rev for D33S/35SC-5 &
G33/35P-5

Maximum working pressure : 25Mpa (250bar)
Maximum speed : 2600 rpm
Rotation : clockwise when seen from shaft end



Lift Cylinders

Standard

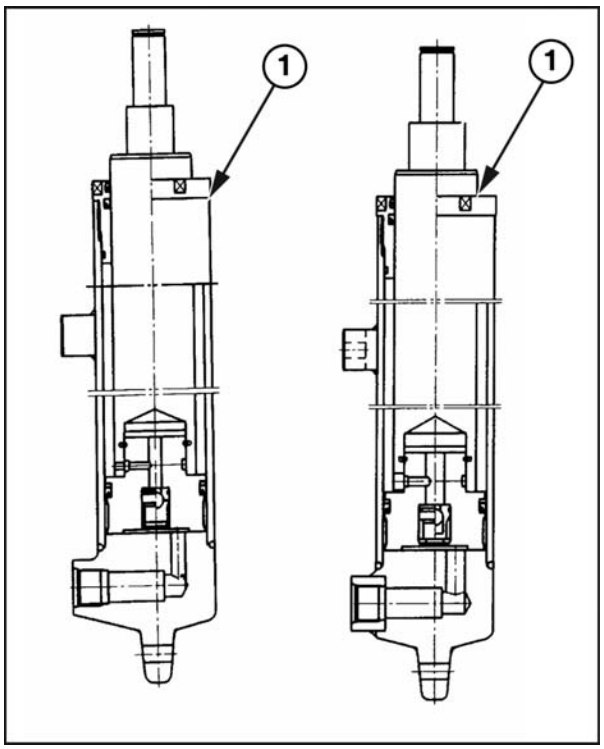


1. Put pipe sealant on the last three threads of bearing.

2. Torque for setscrews ....6±1 N·m (53 ± 9 lb·in)

NOTE: All seals to be lubricated with hydraulic oil.

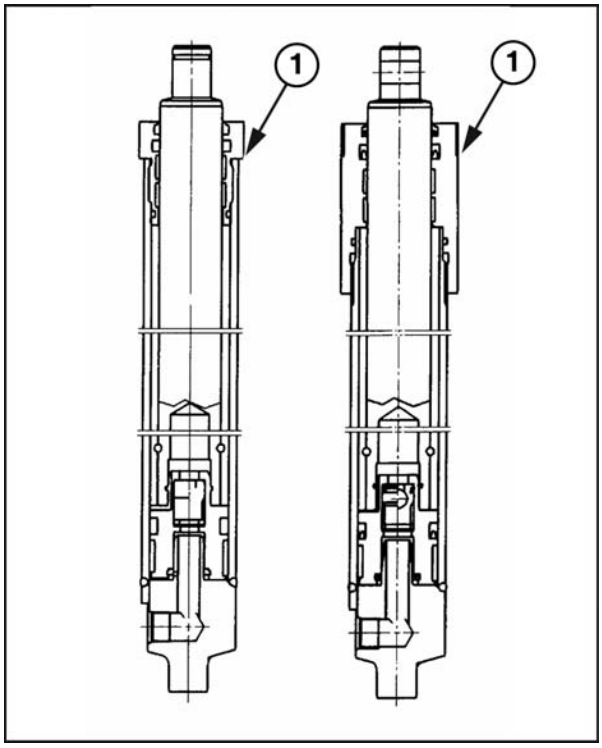
Full Free Triple Lift and Full Free Lift Primary



1. Put pipe sealant on the last three threads of bearing.

NOTE : All seals to be lubricated with hydraulic oil.

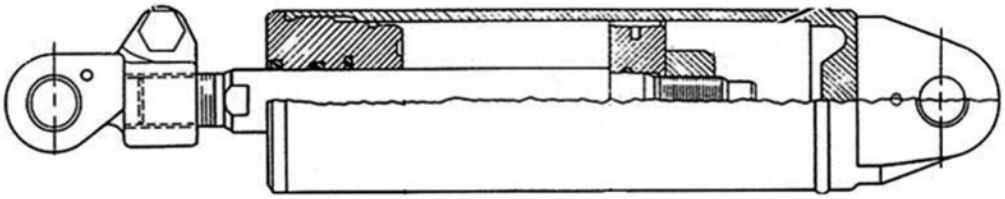
Full Free Triple Lift and Full Free Lift Secondary



1. Put pipe sealant on the last three threads of bearing.

NOTE: All seals to be lubricated with hydraulic oil.

Tilt Cylinder



TILT CYLINDER GROUP						
TILT ANGLE (FOR-BWD)	PART NO					
	STD		FF		FFT	
	D.G20/25S-5 D.G30/32/33S-5 D35C-5	GC20/25S-5 GC30/32S-5	D.G20/25S-5 D.G30/32/33S-5 D35C-5	GC20/25S-5 GC30/32S-5	D.G20/25S-5 D.G30/32/33S-5 D35C-5	GC20/25S-5 GC30/32S-5
3˚ - 3˚	–	–	–		A215192	A215207
6˚ - 3˚	A215179	A215203	–	–	A215179	A215203
3˚ - 5˚	A215191	A215206	A215191	A215206	A215191	A215206
6˚ - 5˚	A215174	A215202	A215174	A215202	A215174	A215202
10˚ - 5˚	–	A215209	–	A215209	–	A215209
3˚ - 8˚	A215190	A215205	A215190	A215205	A215190	–
6˚ - 8˚	A215173	A215201	A215173	A215201	A215173	–
3˚ - 10˚	A215189	–	A215189	–	–	–
6˚ - 10˚	A215172	–	A215172	–	–	–

* Permissible tolerance of 1/2°

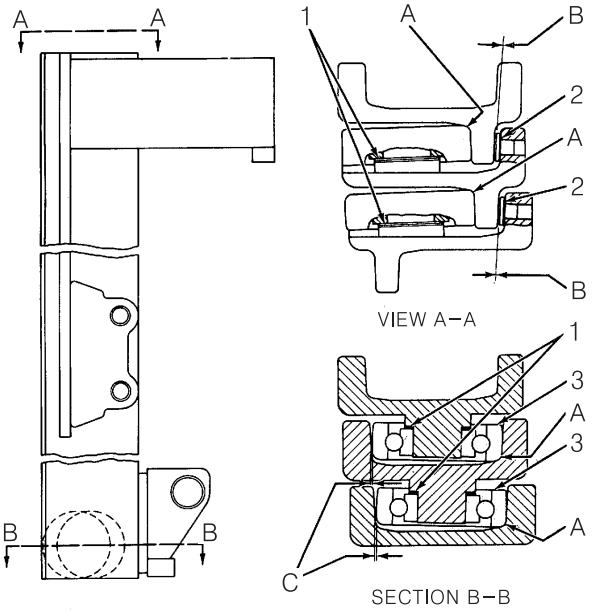
(1) Adjust pivot eye to dimension (Z) with cylinder closed.

(2) Torque for bolt…….95 ± 15 N·m (70 ± 10 lb·ft)

(3) Torque for head……..270 ± 30 N·m
(200 ± 22 lb·ft)

(4) Torque for piston nut…… 270 ± 30 N·m
(200 ± 22 lb·ft)

Mast



IDCS172S

1. With mast at 475 mm (18.7 in) channel lap, equally shim both sides until contact (A) is made (zero clearance) between bearings and mast uprights.

2. With mast at full extension, shim behind pads until there is clearance (B) between the mast uprights and the pads of……...0.80 mm (.031 in)

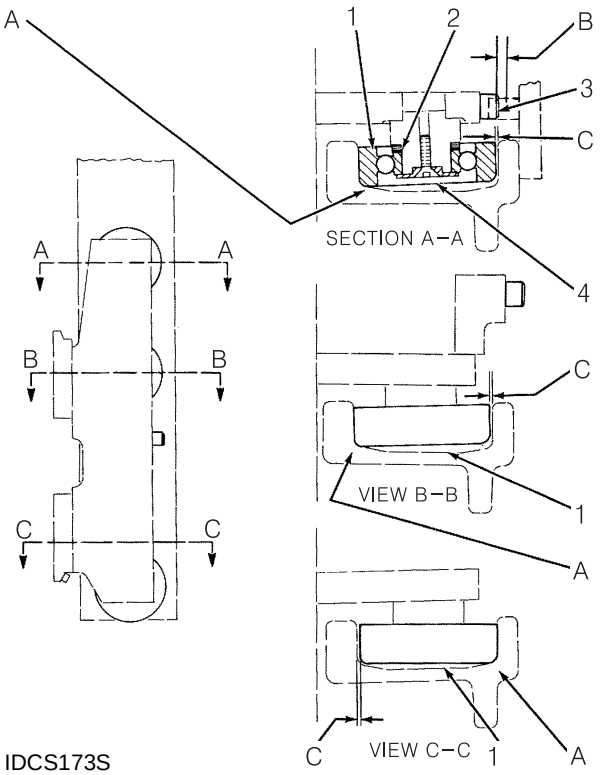
3. Select lower bearings from the chart to obtain minimum clearance (C) between bearing and channel leg for full channel length. Use same bearing on left and right side.

(See Mast Adjustment in Testing & Adjusting).

MAST BEARING CHART		
D581814	Undersize	108.60mm (4.276in)
D581815	Standard	109.60mm (4.315in)
D581816	Oversize	110.70mm (4.358in)

* Permissible tolerance of ± 0.08 mm (.003 in).

Carriage



IDCS173S

1. Select bearings from the chart to obtain minimum clearance (C) between bearings and channel leg for full channel length. Use same bearing at all six locations.

2. Equally shim both sides until contact (A) is made (zero clearance) between bearings and inner mast at narrowest point.

3. Shim bolt as needed to obtain a 6.0 to 9.0 mm (.236 to .354 in) overlap (B) between bolt (3) and the carriage stop on the inner upright.
(See Carriage Adjustment in Testing & Adjusting).

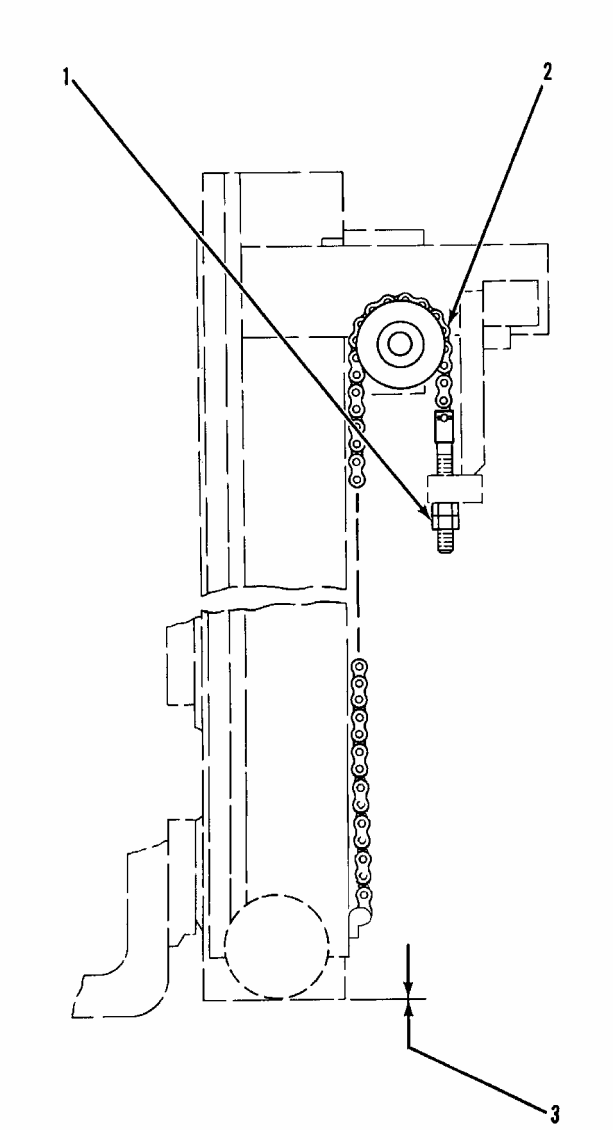
4. Torque for screw.....34±7 N·m (360 ±24 lb·in)

CARRIAGE BEARING CHART		
Part No.	Bearing Size	Bearing OD*
D581814	Undersize	108.60mm (4.276in)
D581815	Standard	109.60mm (4.315in)
D581816	Oversize	110.70mm (4.358in)

*Permissible tolerance of ± 0.08 mm (.003 in).

Lift Relay Group

Standard Lift



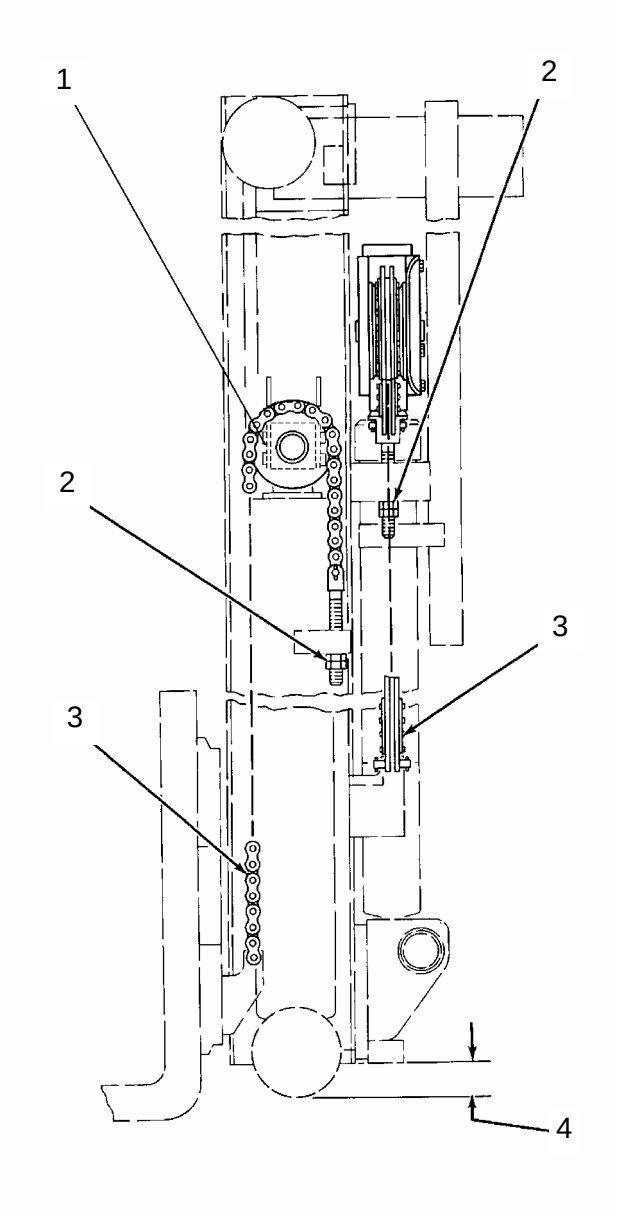
IDCS174S

⚠ WARNING

Do not put a lift truck into service if the chain wear indication is 2% or more. A reading of 2% or more could cause damage or injury to persons.

1. Put LOCTITE NO. 242 Thread Lock on the threads of the relay group locknuts after adjustment of the lift chains is completed.
2. Maximum chain we…….Less than 2% (See Chain Wear Test in TESTING & ADJUSTING).
3. Distance from bottom of inner mast to bottom of lower bearing on carriage must be even (flush) with the inner mast.

Full Free Lift



IDCS175S

⚠ WARNING

Do not put a lift truck into service if the chain wear indication is 2% or more. A reading of 2% or more could cause damage or injury to persons.

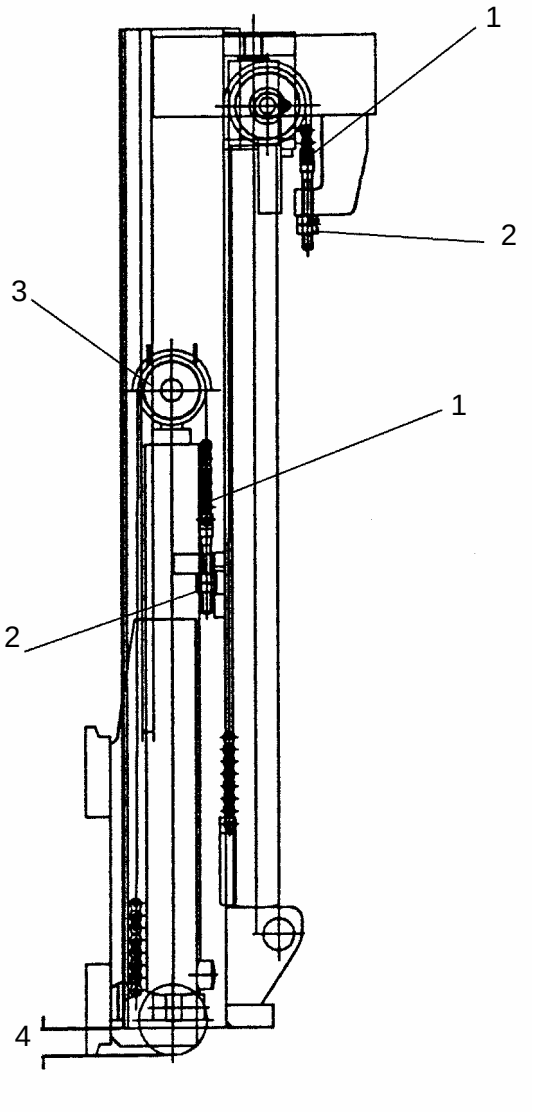
1. Tighten bolts until contact is made with guard.

2. Put LOCTITE NO. 242 Thread Lock on the threads of the relay group locknuts after adjustment of the lift chains is completed.

3. Maximum chain wear……Less than 2% (See Chain Wear Test in TESTING & ADJUSTING).

4. Distance from bottom of inner mast to bottom of lower bearing on carriage must be 41±1.5 mm (1.61 ±0.6 in). Bottom of inner mast must be even (flush) with bottom of stationary mast. Adjust inner first.

Full Free Triple



IDCS193S

⚠ WARNING

Do not put a lift truck into service if the chain wear indication is 2% or more. A Reading of 2% or more could cause damage or injury to persons.

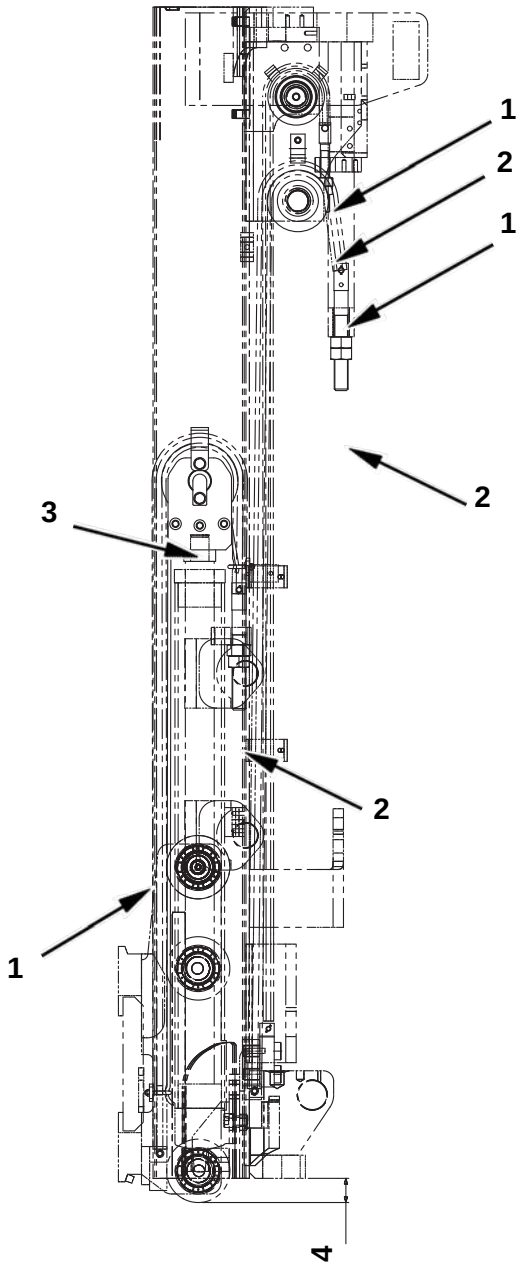
1. Maximum chain wear……Less than 2% (See Chain Wear in TESTING & ADJUSTING).

2. Put LOCTITE NO. 242 Thread Lock on the threads of the relay group locknuts after adjustment of the lift chains is completed.

3. Tighten bolts until contact is made with guide assembly.

4. Distance from bottom of inner mast to bottom of lower bearing on carriage must be 41±1.5 mm (1.61 ± 0.6 in). Bottom of inner mast be even (flush) with bottom of stationary mast. Adjust inner mast first

Quad Lift



⚠ WARNING

Do not put a lift truck into service if the chain wear indication is 2% or more. A Reading of 2% or more could cause damage or injury to persons.

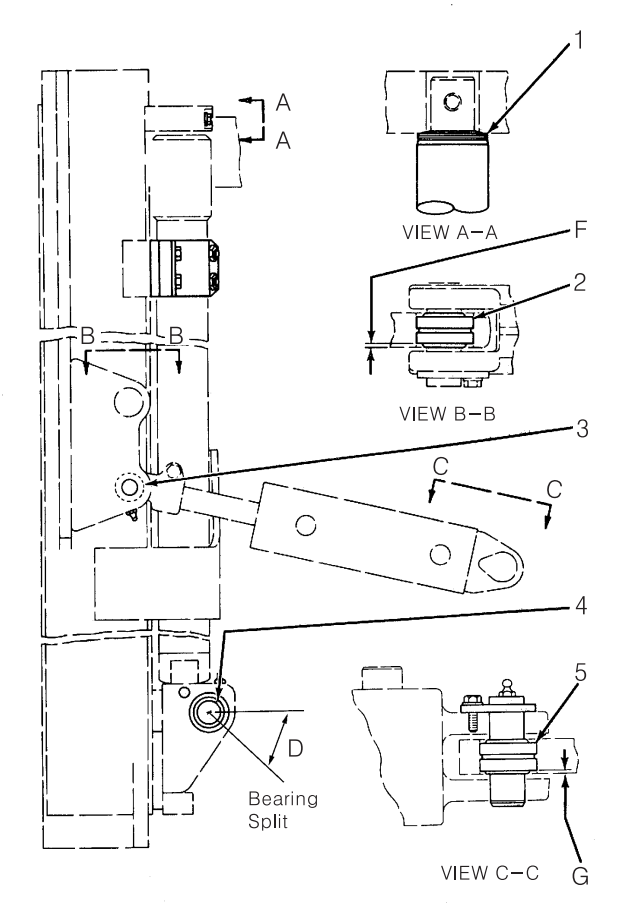
1. Maximum chain wear..... Less than 2% (See Chain Wear in TESTING & ADJUSTING).

2. Put LOCTITE NO. 242 Thread Lock on the threads of the relay group locknuts after adjustment of the lift chains is completed.

3. Tighten bolts until contact is made with guide assembly.

4. Distance from bottom of inner mast to bottom of lower bearing on carriage must be 41±1.5 mm (1.61 ± 0.6 in). Bottom of inner mast be even (flush) with bottom of stationary mast. Adjust inner mast first

Lift & Tilt Mounting Group



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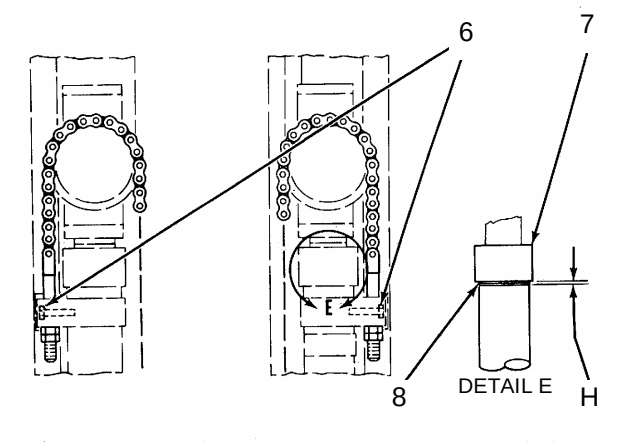


IDCS177S

1. (Standard Mast, Full Free Triple Lift Mast or Quad Lift Mast Only) With chains adjusted for equal tension, run mast to full lift. If mast does not kick (move) to one side, no shims are needed. If mast does kick (move) to one side, disconnect cylinder from the bar on that side. Add shim, connect cylinder, adjust chains and run mast to full lift to check for kick. Repeat process if necessary. The total shim pack must not be more than three shims maximum.

2. Install bearing outer race to a depth of (F) 4.5± 0.8 mm (.177 ± .031 in).

3. Tilt cylinder installation shown.

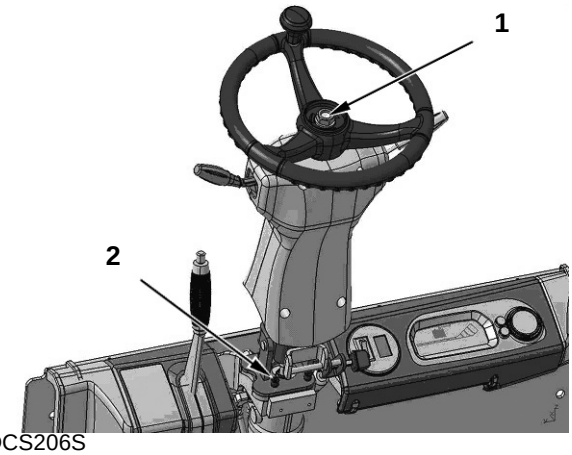
4. Bearing split to be located at angle (D) 45±15°

5. Install bearing outer race to a depth of (G) 4.5± 0.8 mm (.177 ± .031 in).

6. (Full Free Lift Mast Only):
Tighten nuts until U-bolt is firm against cylinder, do not apply standard torque.

7. (Full Free Lift Mast Only):
With chains adjusted for equal tension run mast to full lift. If mast does not kick (move) to one side, no shims are needed. If mast does kick (move) to one side, hold lift cylinder tube on that side and loosen bearing 1/4 turn and check mast again. Loosen bearing until kicking (movement) stops or gap (H) reaches 3.0 mm (.12 in) (approximately 1.5 turns), whichever is less. Insert shims (8) under bearing (it may be necessary to loosen bearing an additional amount of turns to install shims). Tighten bearing again.

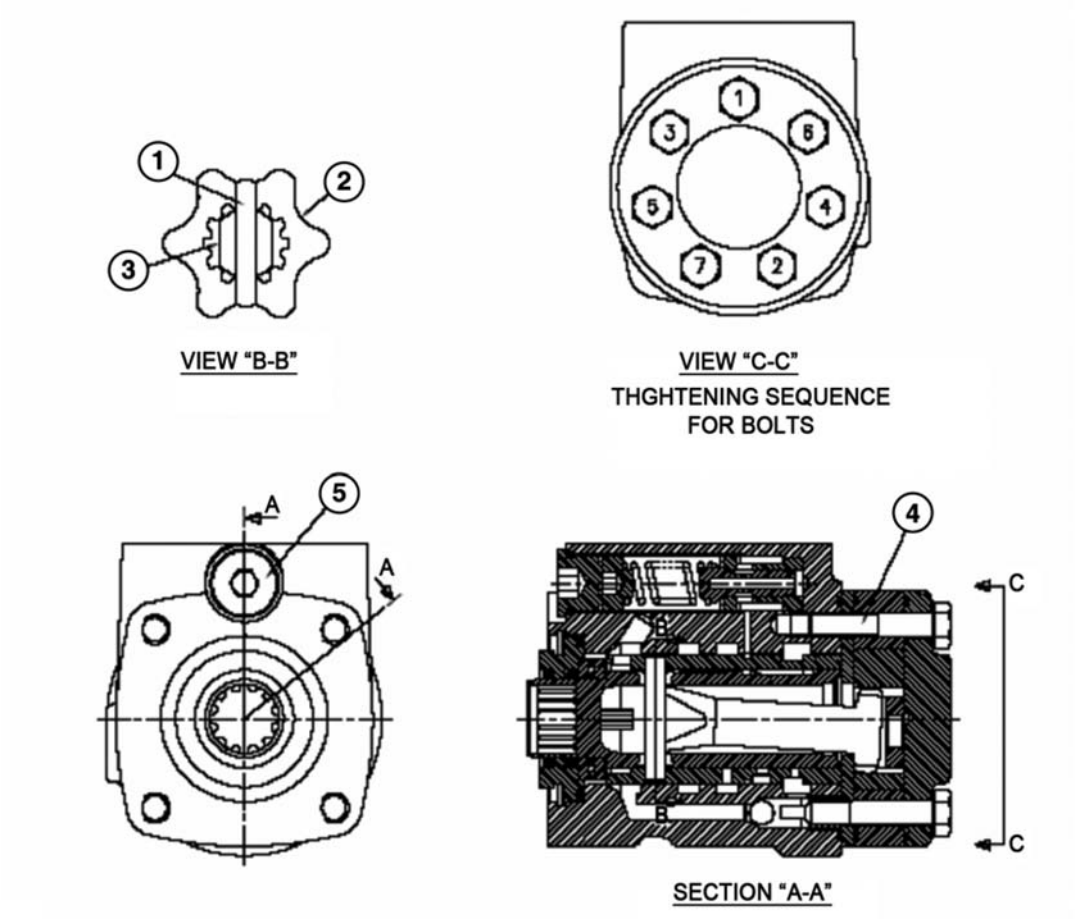
Steering Wheel



IDCS206S

1. Torque for steering wheel nut..... ..... 80 ± 6 N·m (60 ± 4 lb·ft)

Steering Gear



IDCS180S

(1) Pin (1) in the body must be aligned with internal pump gear (gerotor) (2) and drive (3) as shown.

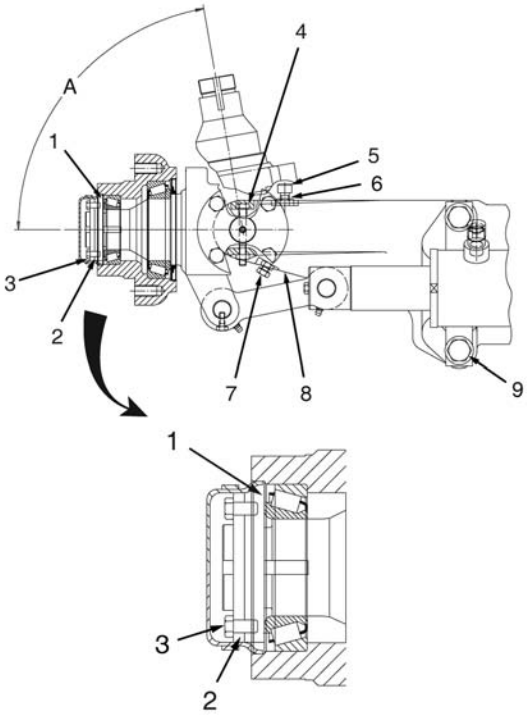
(4) Tighten bolts in sequence shown.

Tighten to a first torque of..... 14.1 ± 2.8 N·m (125 ± 25 lb·in)
Tighten to a final torque of.....28.2 ± 2.8 N·m (250 ± 25 lb·in)

(5) Torque for plug .....11.3 N·m (100 lb·in)

Plug to be flush (even) with or below mounting surface.

Steer Axle and Wheel



NOTE: Steer axles with tapered roller bearings shown.

(1) Do the steps that follow for steer wheel bearing adjustment.

a. Tighten nut ① slowly to 135 N·m (100 lb·ft) while turning the wheel.

b. Loosen nut ① completely.
Tighten it again to .....50 ± 5 N·m (37 ± 4 lb·lft)

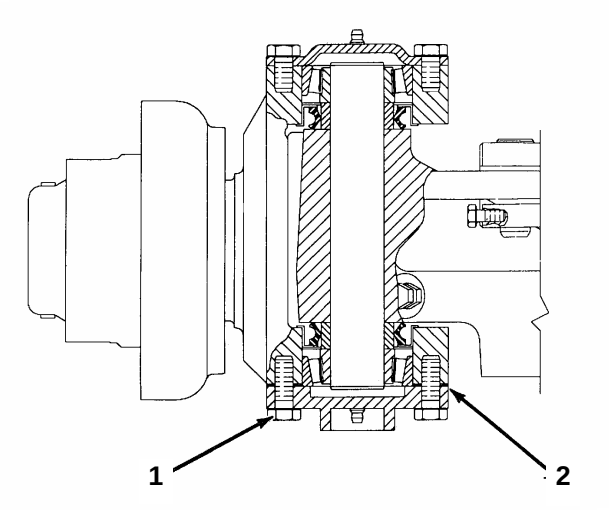
c. Assemble lock washer ② and align the hole for assembling the bolt. If the holes does not match, turn nut ① about 1/32 turn clockwise.

d. Apply loctite 242 on the threads of bolts ③ and tighten them at ..... 8 ± 3 N·m (6 ± 2 lb·ft).

(2) Torque for bolt ④ that holds pin ....11±1 N·m (100 ± 9 lb·ft)

(3) Loosen nuts ⑥ and ⑧ on both sides. Adjust bolts to get steering knuckle turning angle (A) of 78 to 80°.
See Steering Axle Stop Adjustment in Testing And Adjusting section.

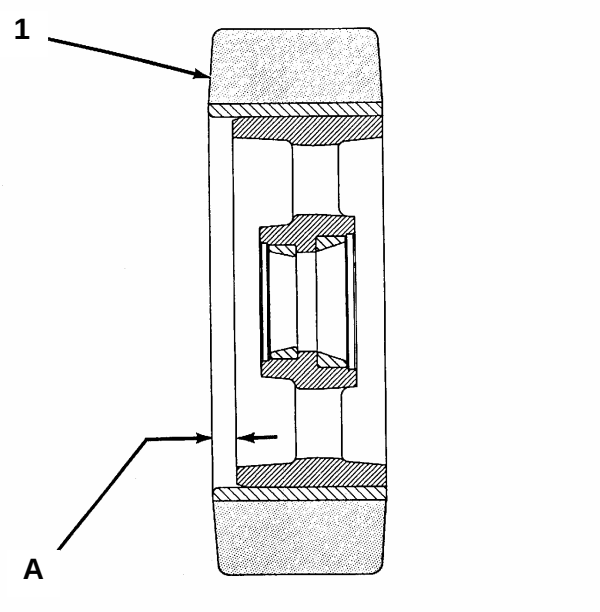
(4) Torque for bolts ⑨ that hold steer cylinder to axle beam……..300 ± 40 N·m (220 ± 30 lb·lft)



(5) Torque for bolts ① that hold cover
…….. 55 ± 6 N·m (40 ± 5 lb·ft)

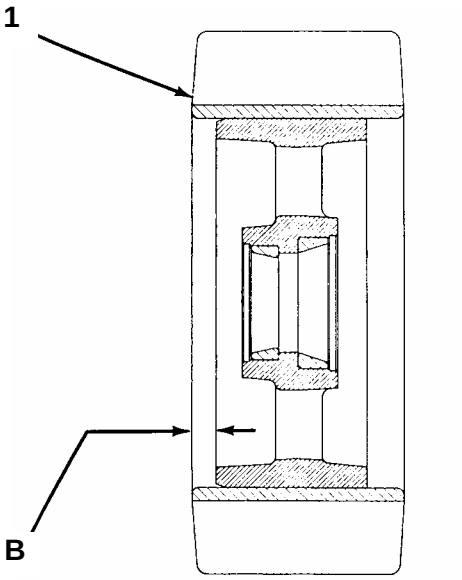
(6) Add or remove shims ③ under cover until torque required to turn knuckle assembly is
……...4.5 to 6.8 N·m (40 to 60 lb·in)
See Steering Knuckle Bearing Preload Adjustment in Testing & Adjusting.

Steer Tire Installation (GC Models Only)



IDCS184S

GC20E/P-5, GC25E/P-5 Models

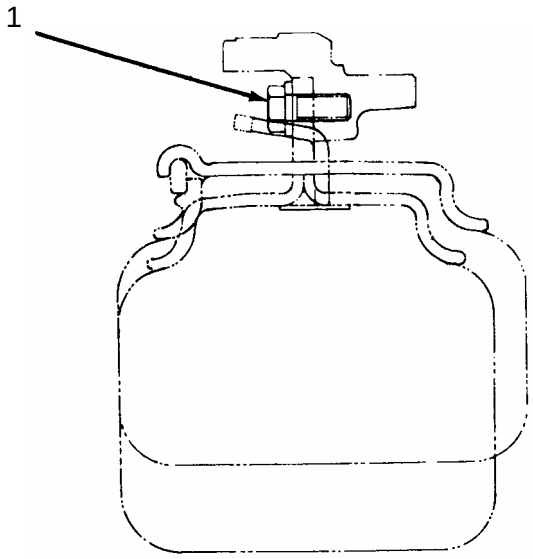


IDCS209S

GC30E/P-5, GC32E/P-5 Model

(1) Install tires to dimension (A) or (B) of .... 17 ± 2 mm (.67 ± .08 in)

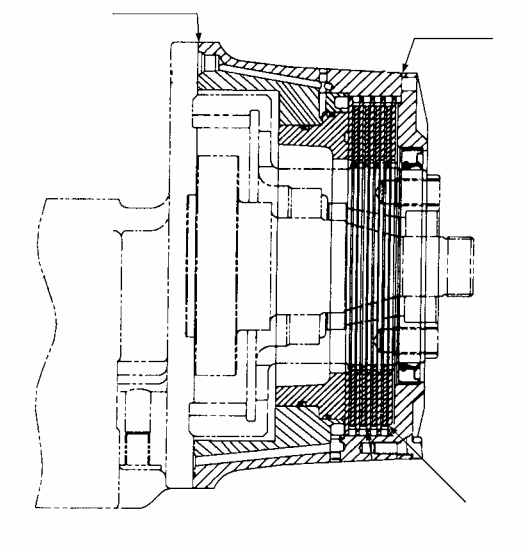
Steer Wheel Mounting



IDCS210S

(1) Torque for bolts that hold steer wheel..... ..... 120 ± 20 N·m (90 ±15 lb·ft)

Oil Cooled Disc Brake



IDCS211S

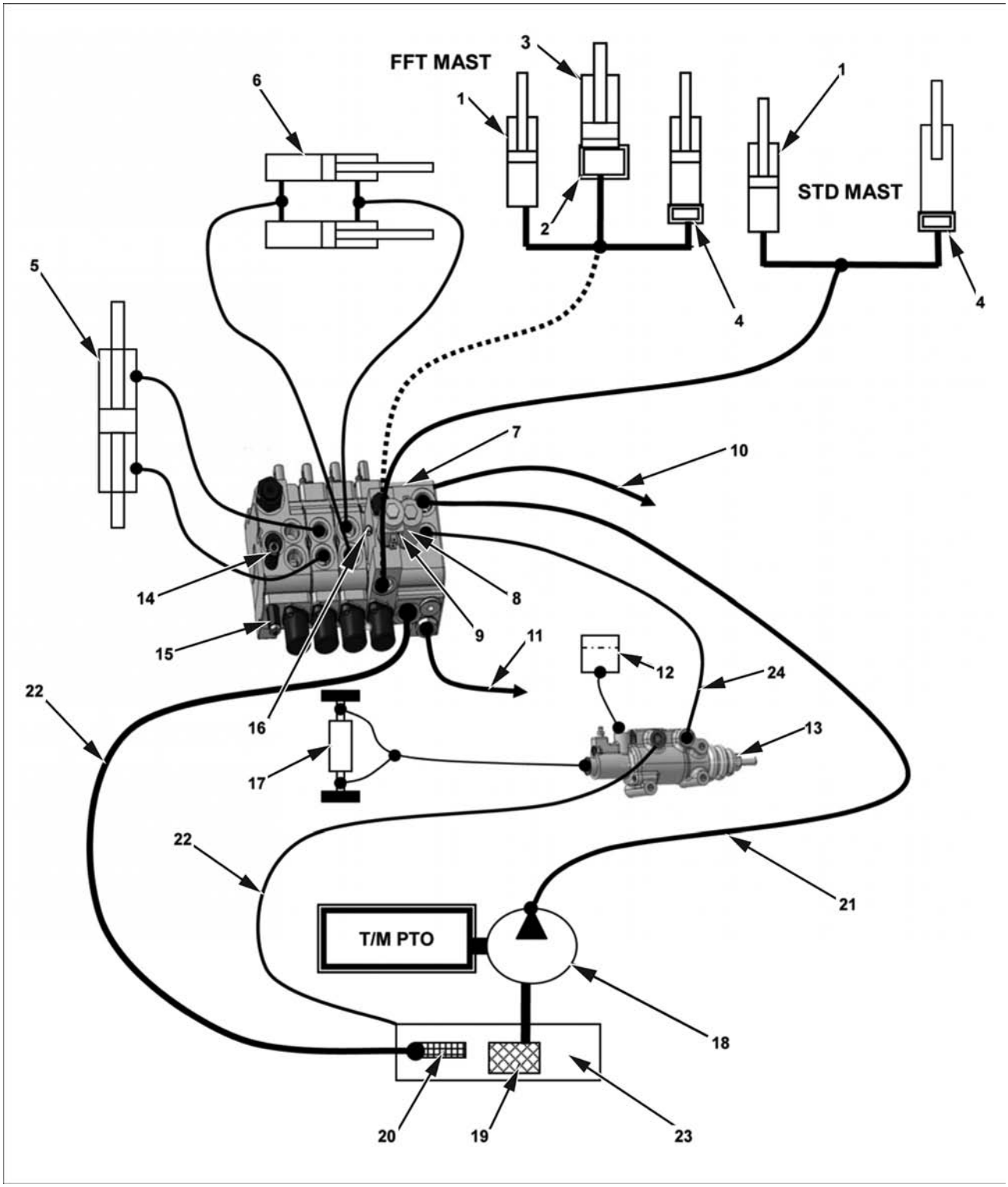
(1), (2) Put LOCTITE NO.17430 Liquid Gasket on contact surface area of the axle flange cover assembly and cover before installation.

(3) Thickness of one new Plate ...2.50 ± .064 mm (.100 ± .0025 in)
Thickness of one new friction disc: .... 4.59 ±.13 mm (.181 ± .005 in)

Minimum depth of grooves before the replacement of frictiondine is necessary ....0.32 mm (.013 in)
Soak new discs in drive axle oil for one hour before installing.

System Operation

Hydraulic Schematic



Basic Hydraulic Actuator System Schematic
1. Lift cylinder-secondary; 2. Flow protector-primary; 3. Lift cylinder-primary; 4. Flow protector-secondary; 5. Cylinder; 6. Tilt cylinder; 7. Control valve; 8. Unload solenoid valve; 9. Lift lock solenoid valve; 10. CF line to steering unit; 11. LS line to steering unit; 12. Brake reservoir; 13. Brake power master cylinder; 14. Relief valve - Tilt/Aux; 15. Relief valve - Main; 16. Needle valve; 17. Drive axle; 18. Gear pump; 19. Suction filter; 20. Return oil filter; 21. Main oil supply line; 22. Return oil line; 23. Hydraulic tank; 24. Brake boost pressure line

The hydraulic gear pump (18) is driven off the transmission PTO which draws oil from the hydraulic oil tank (23). Oil is supplied to the first control valve (7) section through hydraulic line (21). This section also contains the priority valve that distributes oil to the following areas based on, 1st brakes, 2nd steering, and 3rd implement flow demand (mast/tilt/auxiliary functions). A constant flow of 0.8 GPM is provided by the priority valve to the brake power master cylinder (13). From the CF port, oil flows through hydraulic line (10) to the steering unit. From the LS port, oil flows through hydraulic line (11) to the steering unit. The remaining oil from the control valve and the power master cylinder is returned to the hydraulic tank through hydraulic lines (22).

The safety unloader solenoid of the priority valve section prevents oil flow through the control valve when the operator has left the seat thereby preventing any function regardless of lever position. Unloader solenoid valve (8) is electrically connected to the seat switch. The solenoid valve (8) is turned off within 3 seconds of the operator leaving the seat. System pressure drops to less than 7 bar (100 PSI) and oil is diverted to tank instead of flowing through the control valve. Once the operator returns to the seat, the solenoid valve is turned on opening oil flow to the control valve and immediately returning normal work function to the control valve.

An additional safety lift lock function is also included which works much the same as the unloader solenoid mentioned above. This solenoid valve (9) prevents lowering of the carriage and/or mast when the operator leaves the seat more then 3 seconds, or the key switch is off. When the solenoid is off, oil flow is prevented from exiting the lift cylinders if the lever is pushed accidentally. Normal operation returns once the key switch is turned on or the operator returns to the seat.

A needle valve (16) on the side of the lift section can be used in an emergency should the lowering function not work normally. Approximately one half turn counter-clockwise makes it possible to lower the mast and/or carriage when the lift spool is shifted for lowering. After lowering the mast or carriage to the ground and with the start key off, inspect for possible causes of the malfunction. Refer to the detailed trouble shooting guide will be shown in TESTING and ADJUSTING.

The lift cylinder lowering speed is controlled by a flow regulator valve integrated into lift spool.

Levers of control valve move spools within the control valve. The movement of spool allows fluid for lift, tilt, and side shift (5) functions. The return hydraulic fluid from each cylinder flows through control valve, hydraulic line (22), through the filter-return (20), and back to a hydraulic tank.

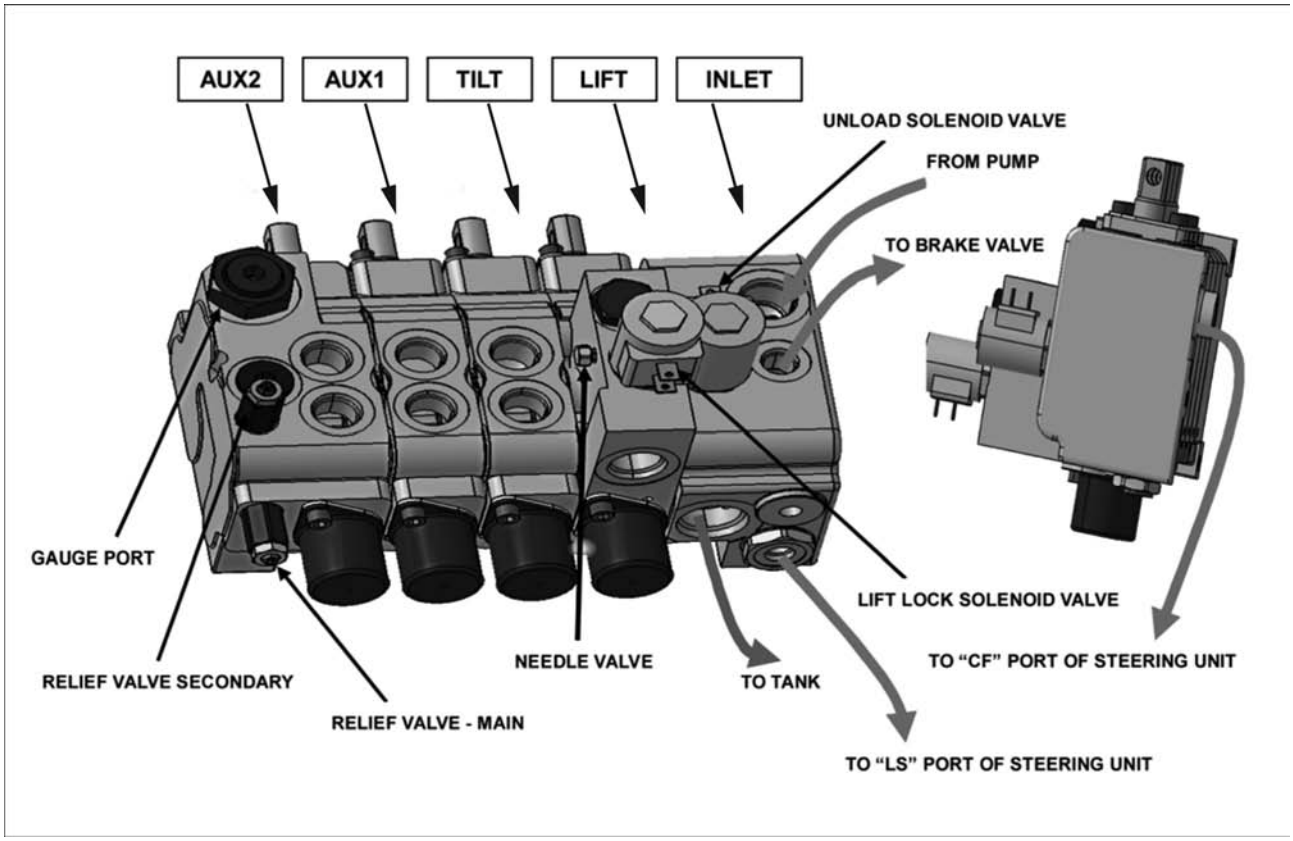
If the pressure in the lift circuit goes higher than the pressure setting shown in the CONTROL VALVE SECTION of SPECIFICATION, the main relief valve (15) opens to control system pressure and dump excess pressure to the hydraulic tank. If the pressures in the tilt and/or auxiliary circuits go higher than the pressure setting shown in the CONTROL VALVE SECTION of SPECIFICATION, the secondary relief valve (14) opens to control system pressure and dump excess pressure to the hydraulic tank.

Flow protectors (2) & (4) integrated in the lift cylinders provide a controlled decent of the mast and/or carriage if a critical hydraulic line is broken. Sudden dropping of the mast and/or carriage is controlled.

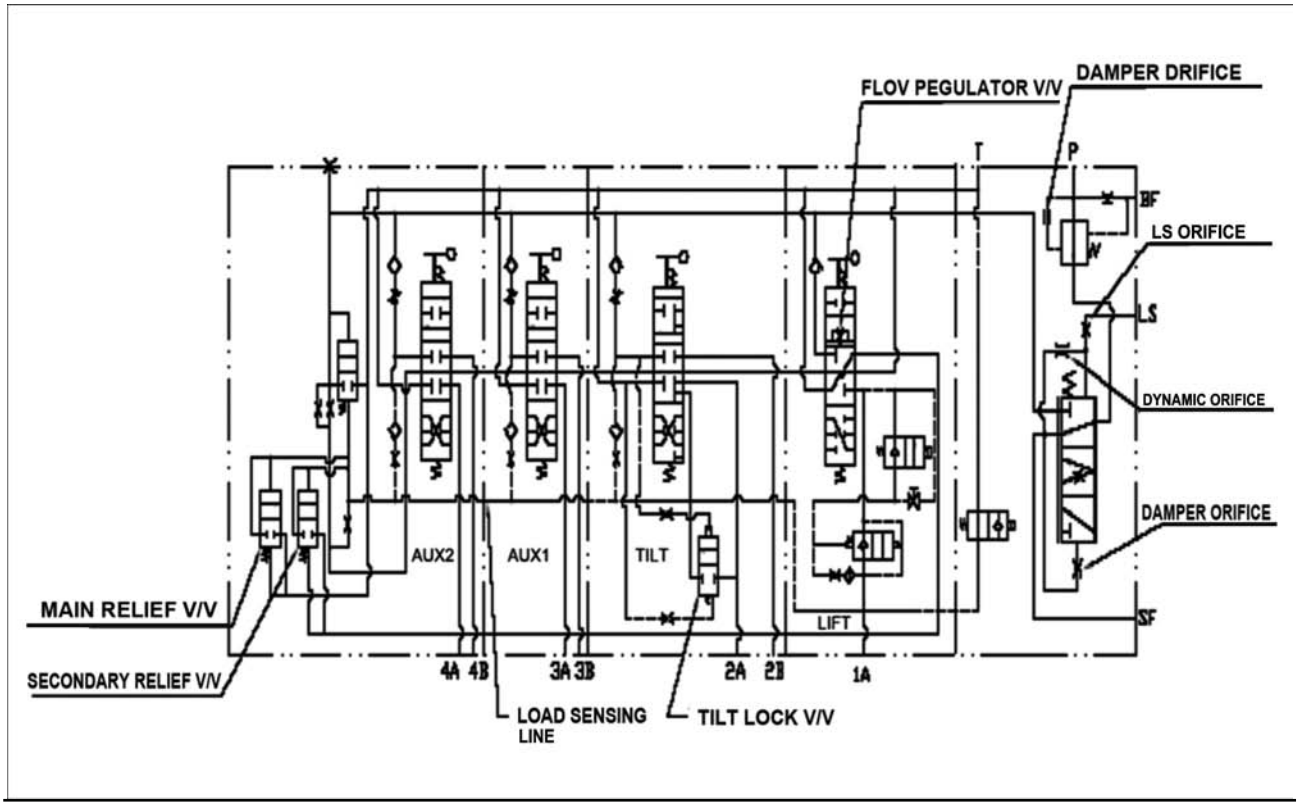
The speed of forward/backward tilt and side shift cylinder extension are controlled by individually adjustable flow controls internal to each section of the control valve. Additionally, the counter-balance valve (or tilt lock valve) in the tilt spool prevents cavitations (development of air pocket) in tilt cylinder. For a complete hydraulic circuit, see the foldout, in the back of this module.

Control Valve

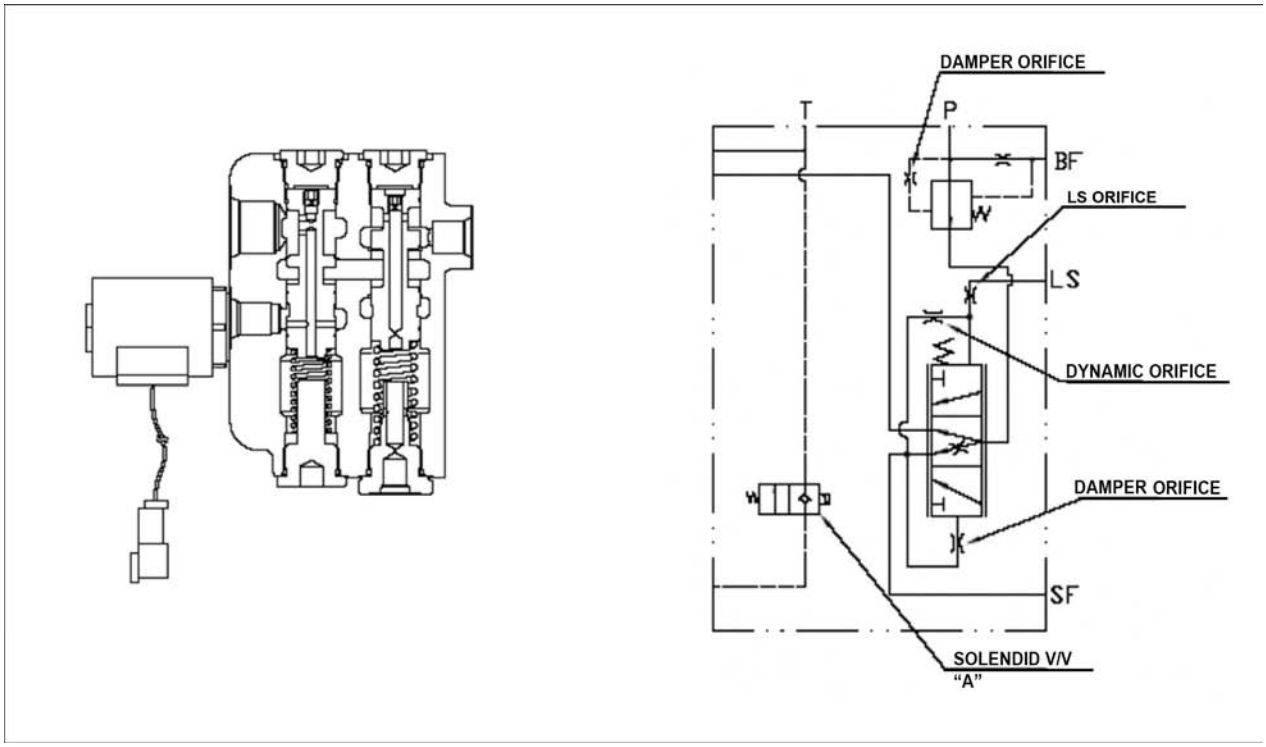
External Configuration



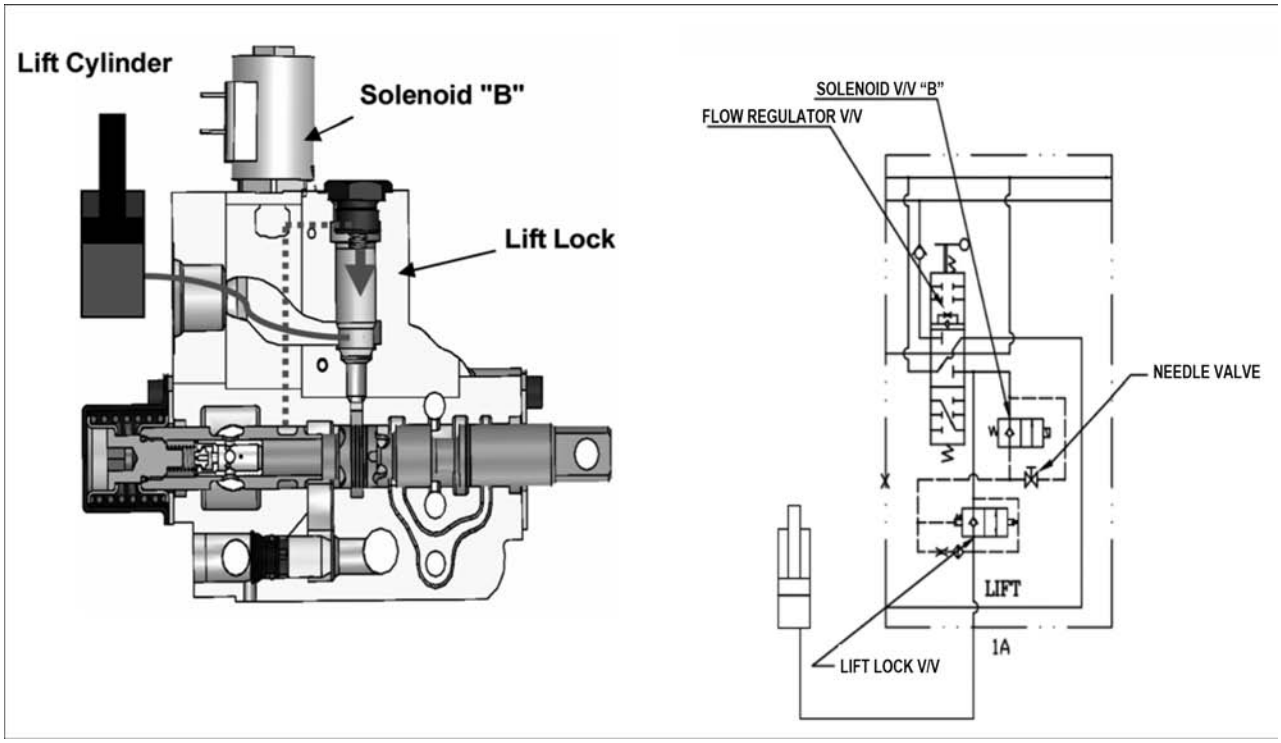
Hydraulic Circuit



Inlet Block - Key On

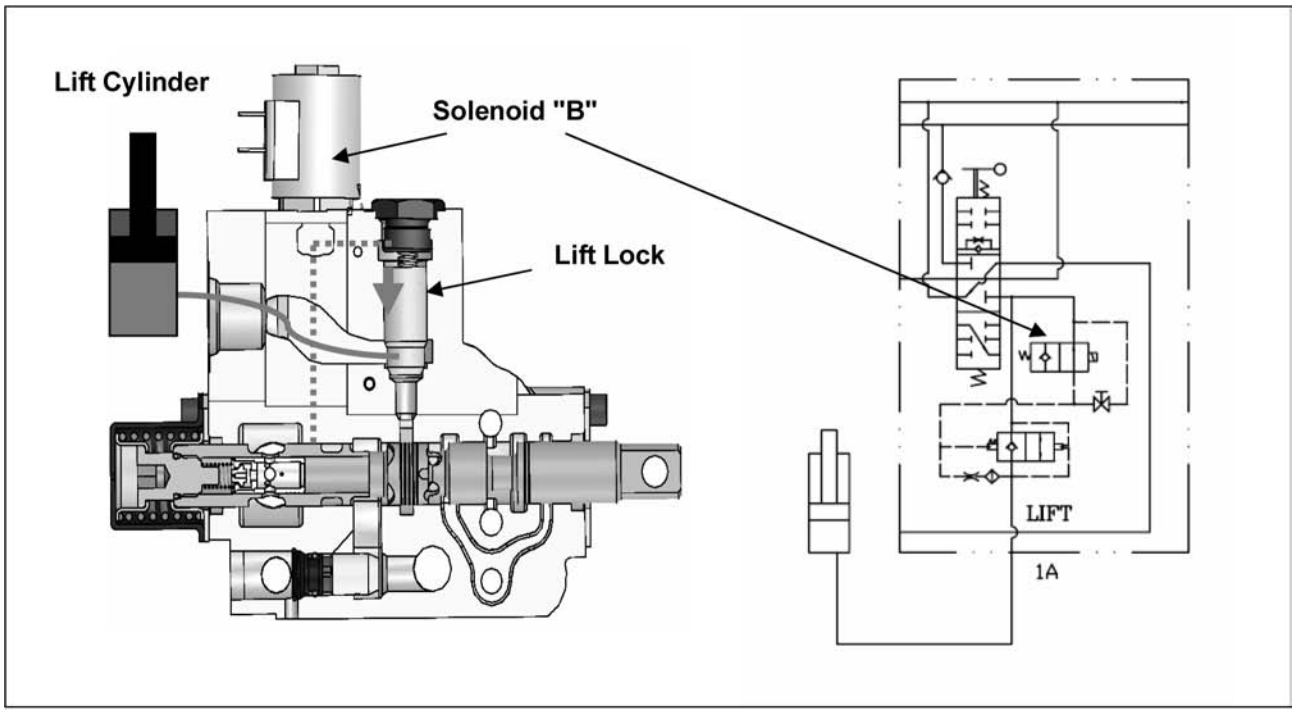


Lift Spool Neutral Position - Solenoid and Key Off



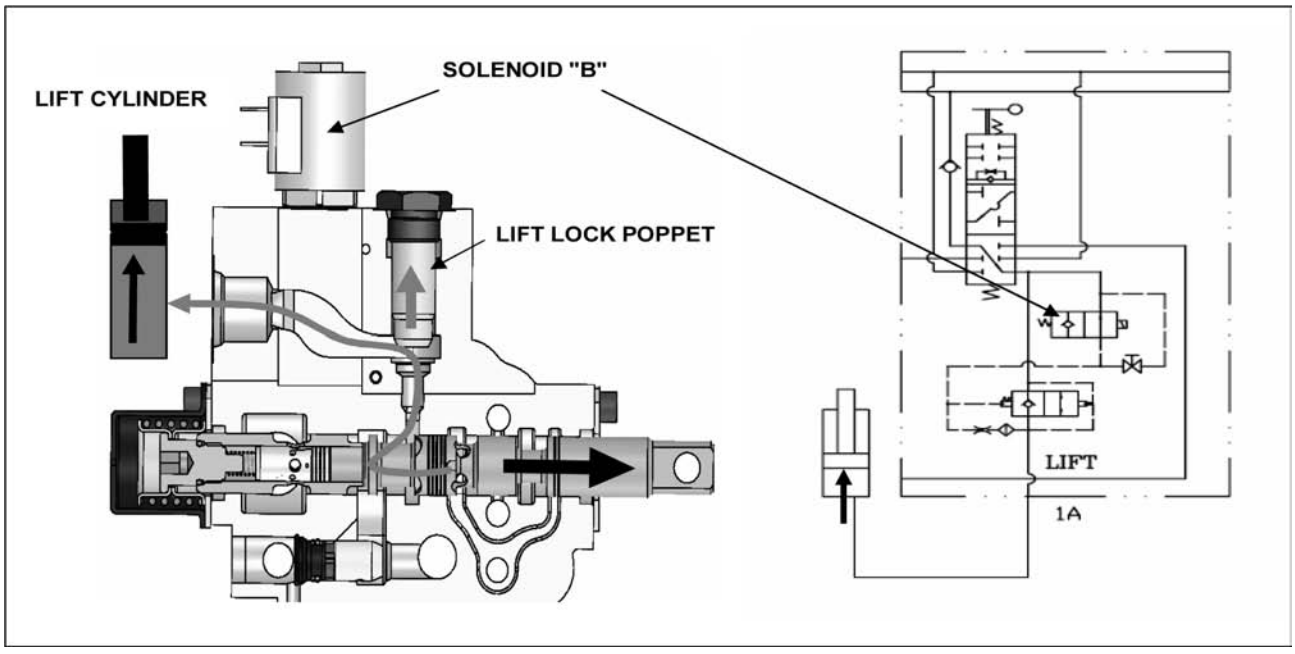
The above figure shows the lift spool in neutral position with key switch off. The solenoid valve is de-energized and blocks lift cylinder return oil flow through the control valve passage to tank. Lift lock also blocks fluid passage of lift cylinder to tank.

Lift Spool Neutral Position - Solenoid and Key On



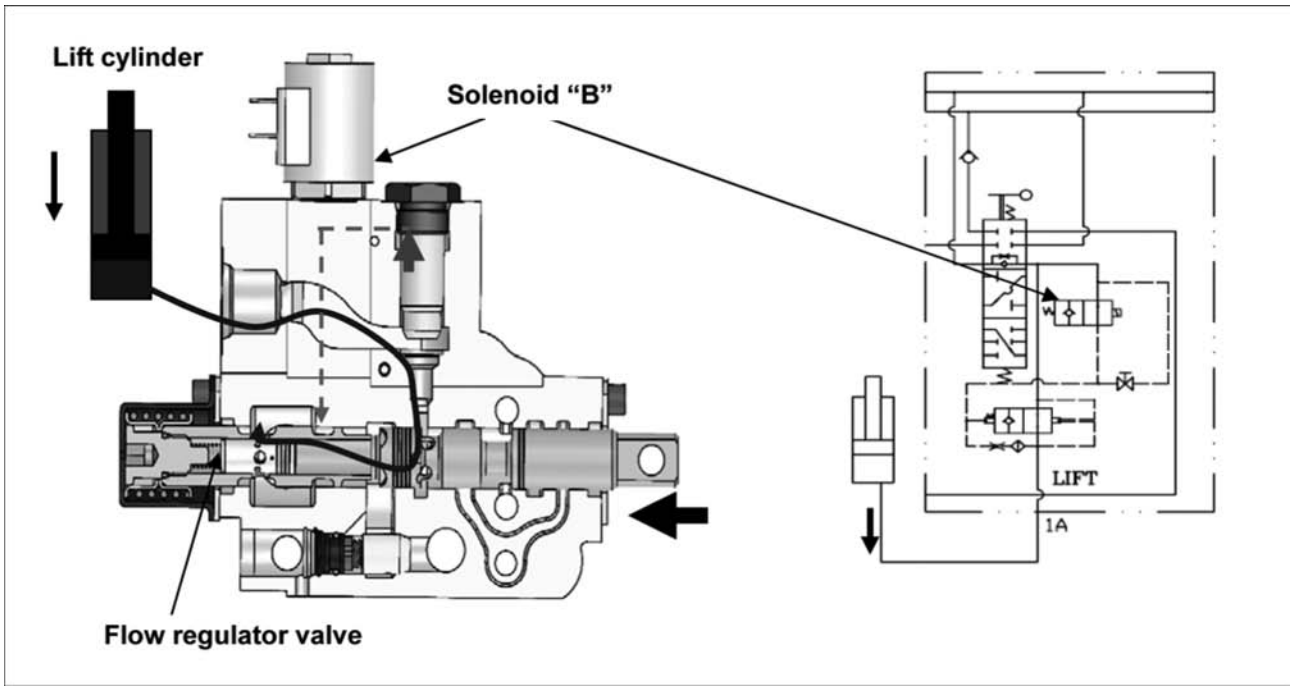
The above figure shows the lift spool in neutral position with key switch on. The solenoid valve is energized and opens to allow oil flow to tank. The lift lock remains closed and blocks oil flow through passage to tank.

Lift Spool - Positioned to Lift



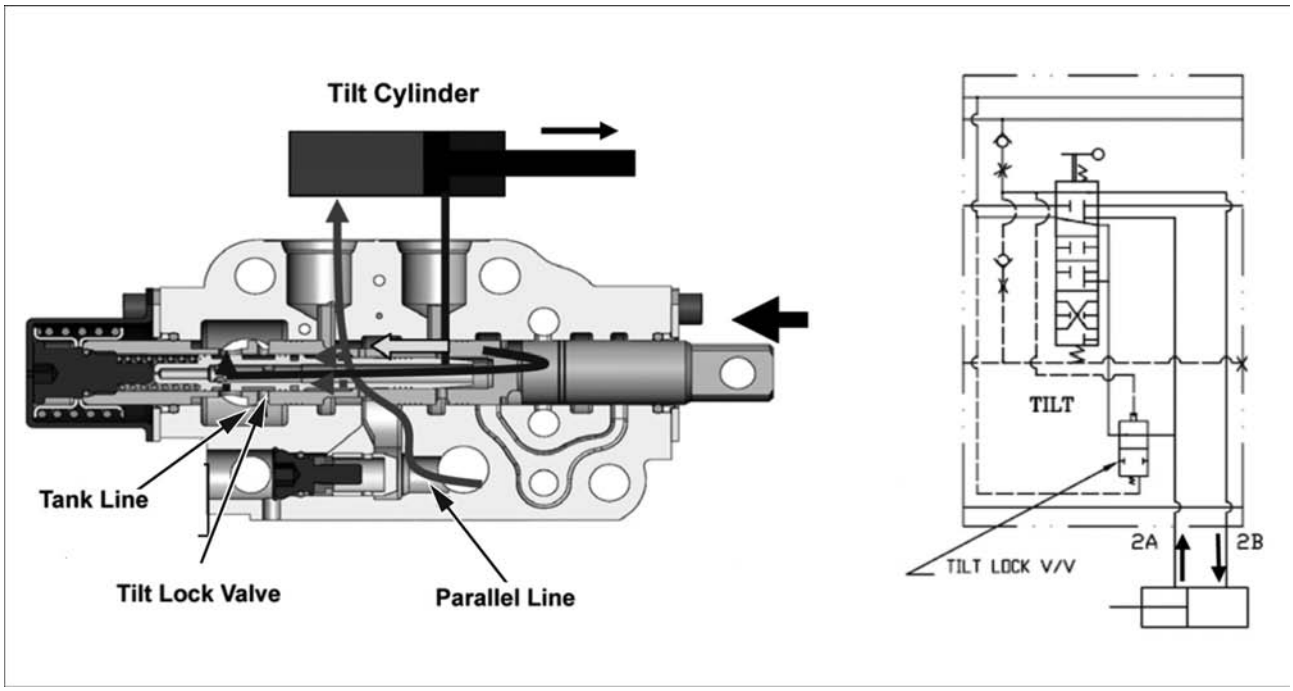
With lift spool pulled out, fluid goes through a load check valve, spool and lift lock to lift cylinder. Lift cylinder is extended.

Lift Spool - Positioned to Lower



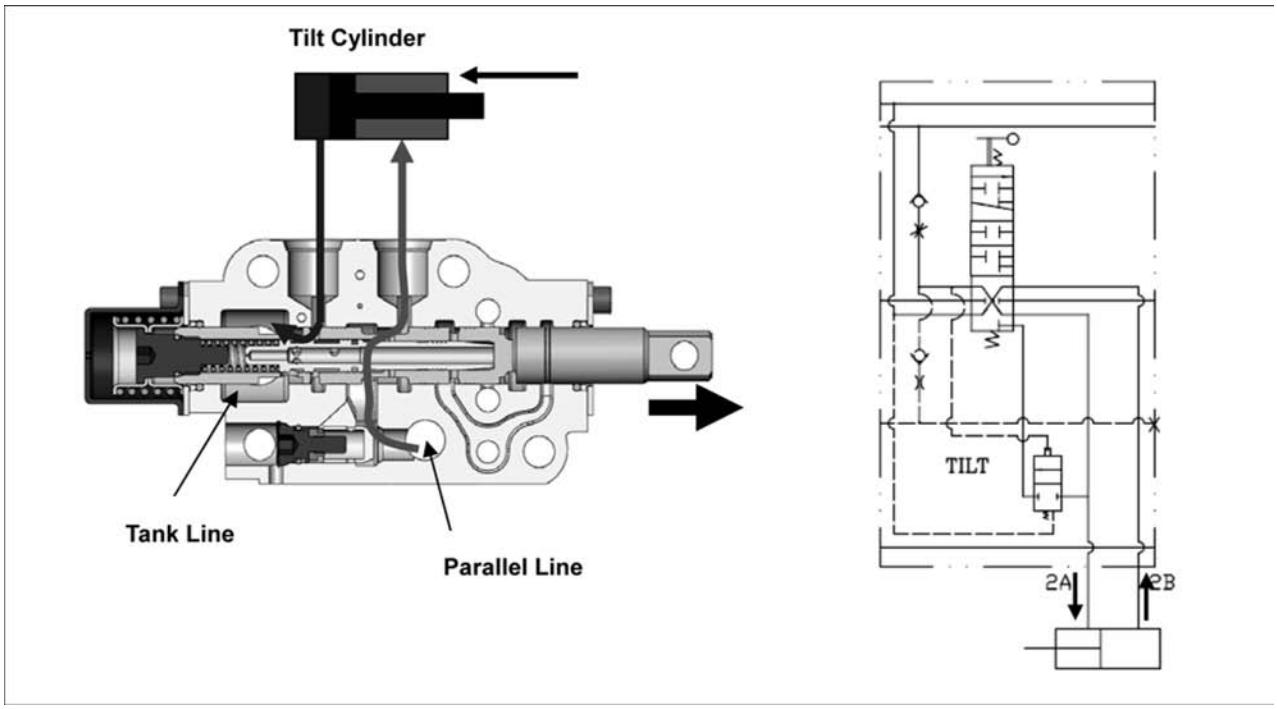
With lift spool pushed in, fluid passes from lift cylinder to tank. The fluid goes through lift lock, lift spool, flow regular valve and tank and the lift cylinder lowers. The flow regulator valve permits a consistent lowering speed of lift cylinder regardless of load.

Tilt Spool - Positioned for Forward Tilt



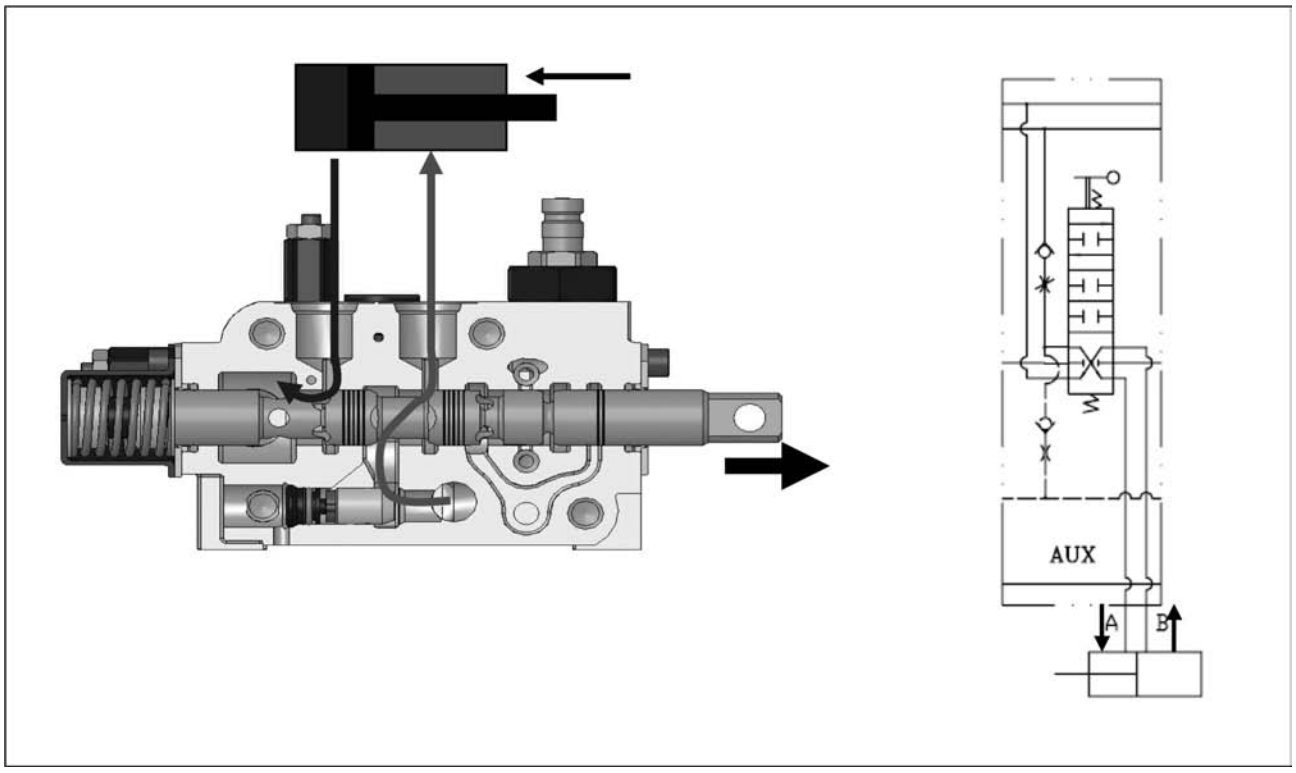
On shifting tilt spool in, the fluid passage of pump to tilt cylinder is made. Pump fluid goes through a load check valve, tilt spool to a head side of tilt cylinder. At the same time, the fluid of rod side of tilt cylinder goes through the tilt lock to tank. The tilt cylinder is moved forward.

Tilt Spool - Positioned for Backward Tilt

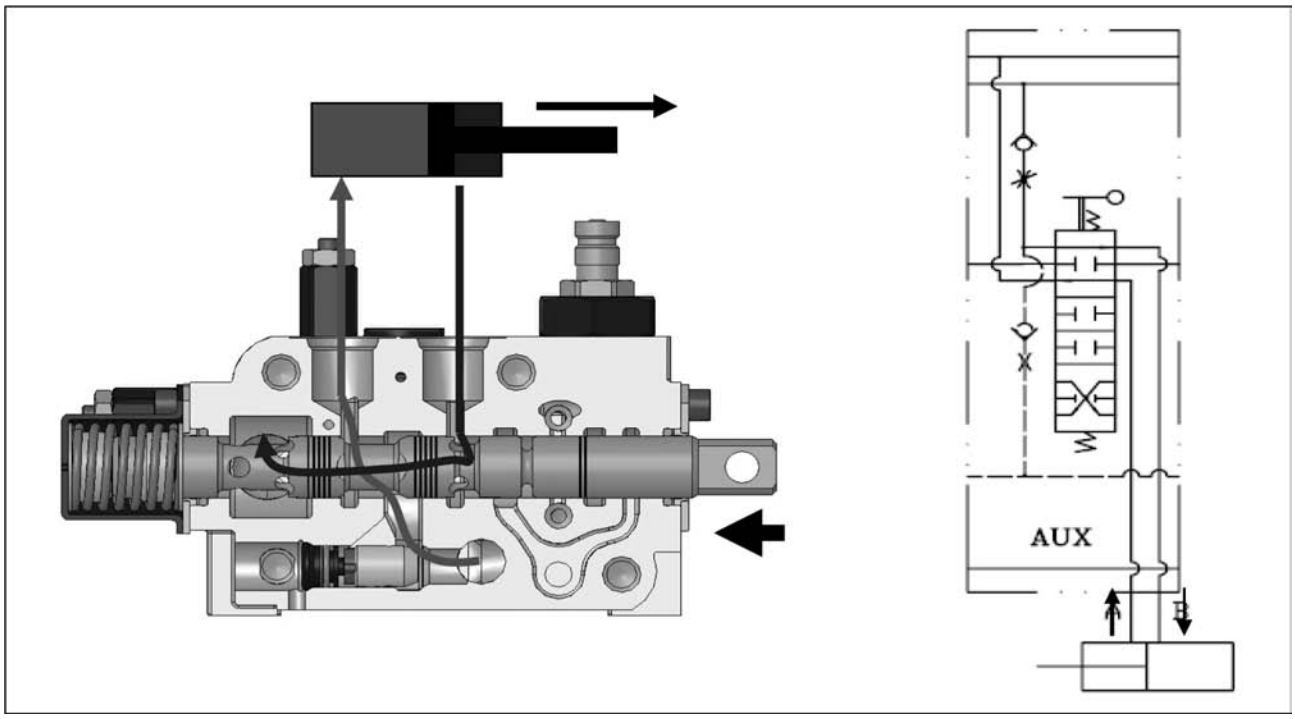


On shifting tilt spool out, the fluid passage of pump to tilt cylinder is made. Pump fluid goes through a load check valve, tilt spool to a rod of tilt cylinder. At the same time, the fluid of a head side of tilt cylinder goes through spool to tank. The tilt cylinder is moved backward.

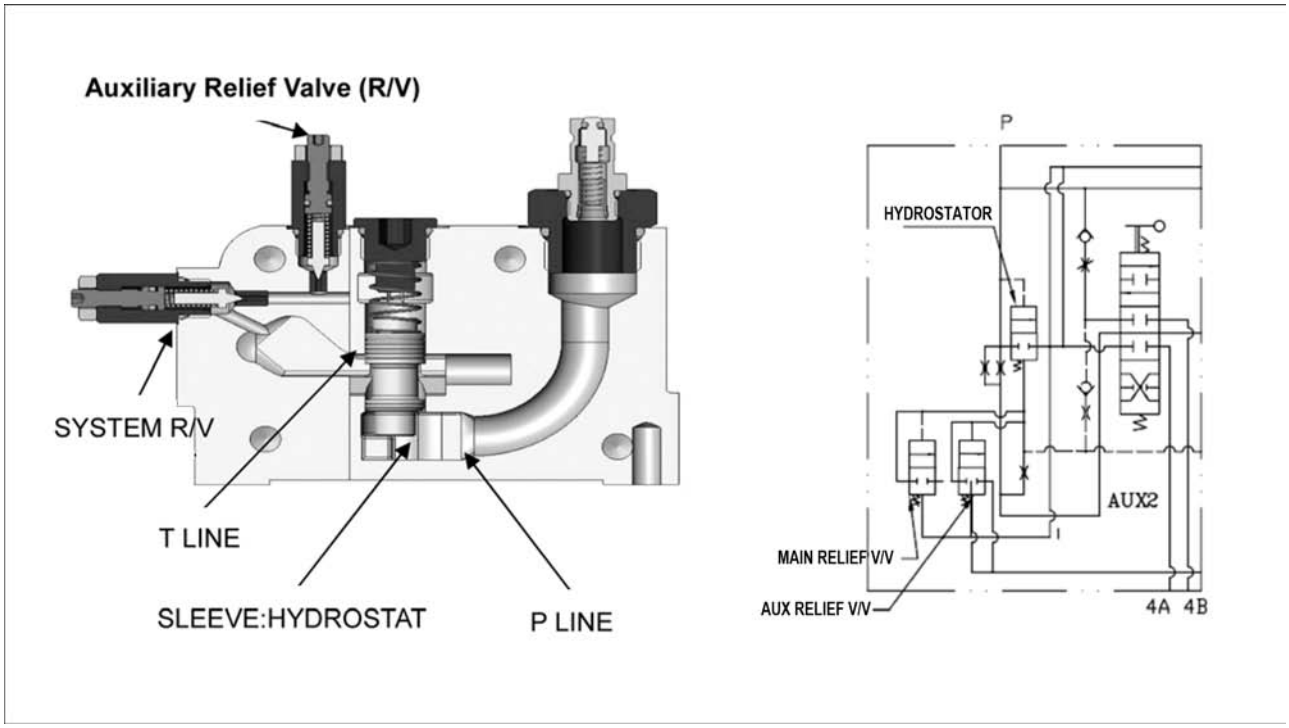
Auxiliary Spool - Positioned for Left Hand Shifting



Auxiliary Spool - Positioned for Right Hand Shifting

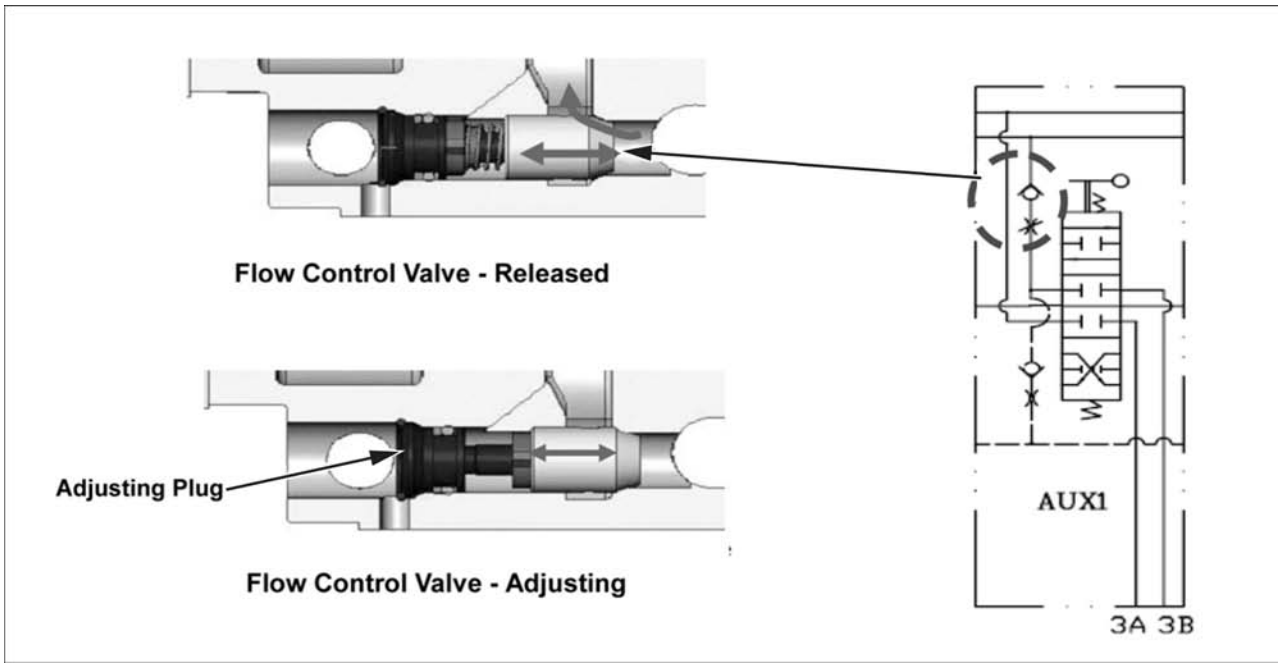


Pressure and Flow Control Section



The main relief valve (system R/V) limits the MAX. lift pressure. The auxiliary relief valve limits the max. tilt and auxiliary system relief pressure. The hydrostat will by-pass the remaining flow back to tank according to the flow control valve in tilt and auxiliary section.

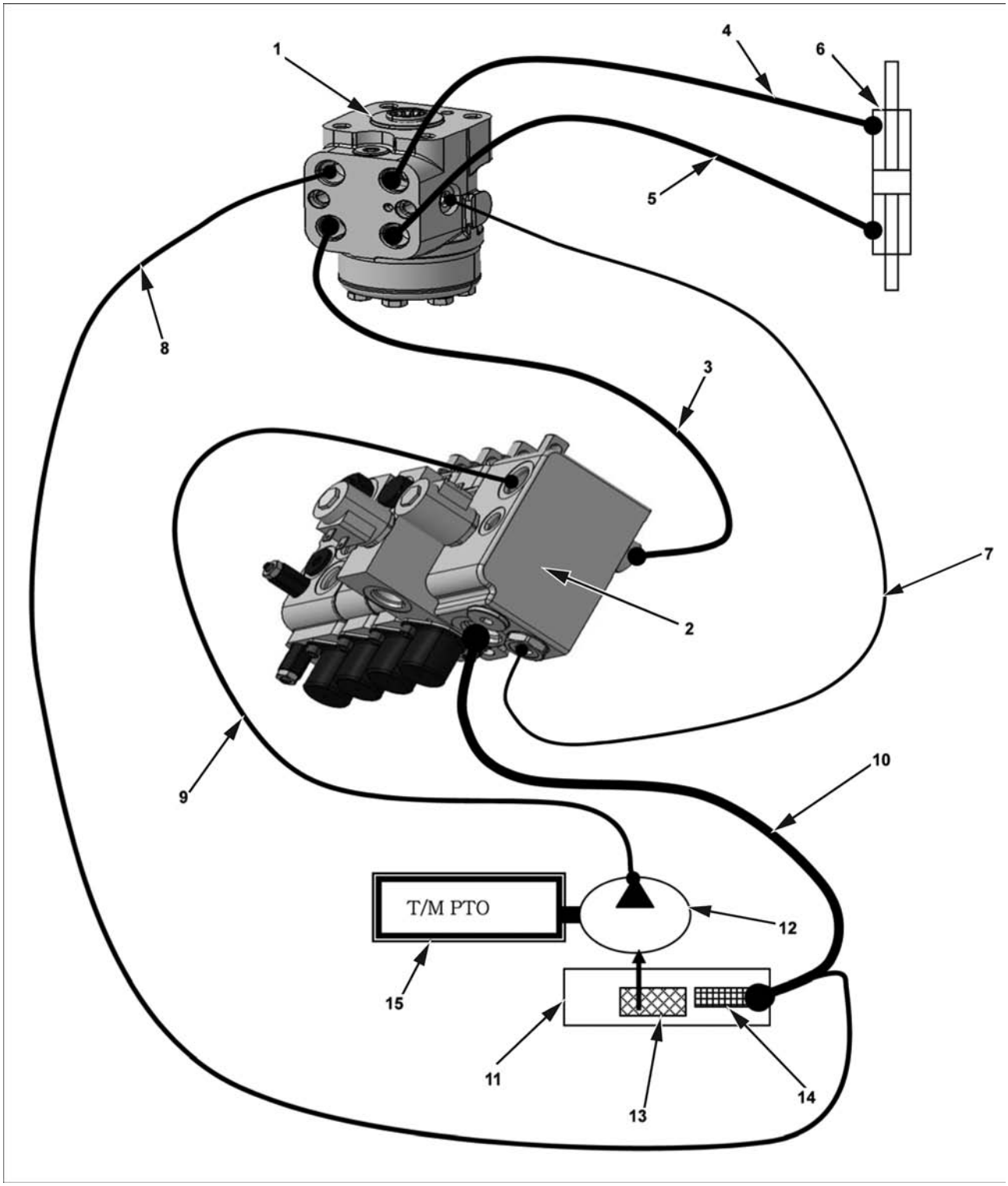
Flow Control Adjustment - Tilt and Auxiliary



Tilt and auxiliary sections have the capability to adjust flow to the actuating cylinders. Clockwise rotation of the adjustment screw will increase hydraulic flow to the cylinders and increase extension or retraction speed. Counter-clockwise rotation of the adjustment screw will decrease hydraulic flow to the cylinders and reduce extension or retraction speed.

STEERING SYSTEM

Hydraulic Schematic



Steering system schematic

1. Steering unit; 2. Priority valve end of control valve; 3. Steering CF line; 4. Left turn hydraulic line; 5. Right turn hydraulic line; 6. Power steering cylinder; 7. Steering LS line; 8. Steering return oil line; 9. Pump oil supply line; 10. Control & Priority valve return oil line; 11. Hydraulic oil tank; 12. Pump; 13. Suction filter; 14. Return filter; 15. Transmission PTO

The priority valve is integrated to the first block of control valve. This section distributes oil to the following areas based on, 1st brakes, 2nd steering, and 3rd implement flow demand (mast/tilt/auxiliary functions). The priority valve (2) supplies oil from the pump (12) to brakes and steering unit (1) as needed. The fluid is drawn from the hydraulic tank (11) by the pump (12). The pump supplies fluid through hydraulic hose (9) to a first block of control valve (2).

When the steering unit (1) is neutral position, pilot pressure in load sensing line (7) is reduced and the spool of the priority valve is moved downward. Most fluid goes passes through the neutral passage of control valve and hydraulic line (10) back to hydraulic tank (11)

When making a right turn, pilot pressure is increased in load sensing line (7) forcing the priority valve spool to moved toward the right. Oil flows through hydraulic line (3) to the steering unit. From the steering unit the oil flows through a hydraulic line (5) filling the cylinder. This forces the cylinder piston toward to opposite end of the cylinder for a right turn. The piston movement displaces oil from the opposite end of the cylinder which returns to the steering unit though hydraulic line (4) and hydraulic line (10) to the hydraulic tank (11).

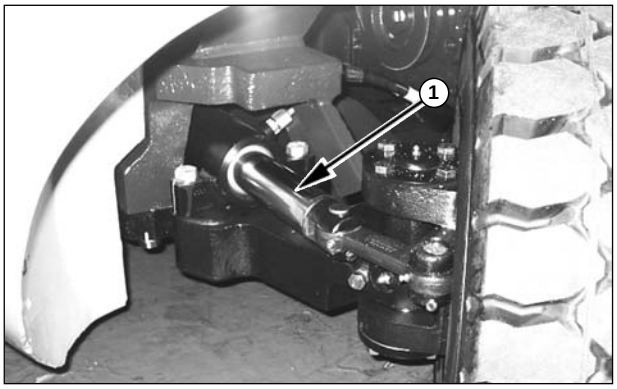
During a left turn, a pilot pressure is again increased in load sensing line (7) which moves the spool of priority valve upward. A fluid flows through a hydraulic line (3) to a steering unit. From the steering unit, the fluid flows through a hydraulic line (4) to a power steering cylinder (6) to make a left turn. The return fluid flows through a hydraulic line (5) back to steering unit, a hydraulic line (8) and into the hydraulic tank.

A check valve is installed into the port of steering unit connected to hydraulic line(3) to prevent a fluid back to priority valve right after a turn is made, Relief valve in steering unit will open if steering pressure goes above 9,000 (+300,-0) kPa or 1,305 (+43, -0) psi.

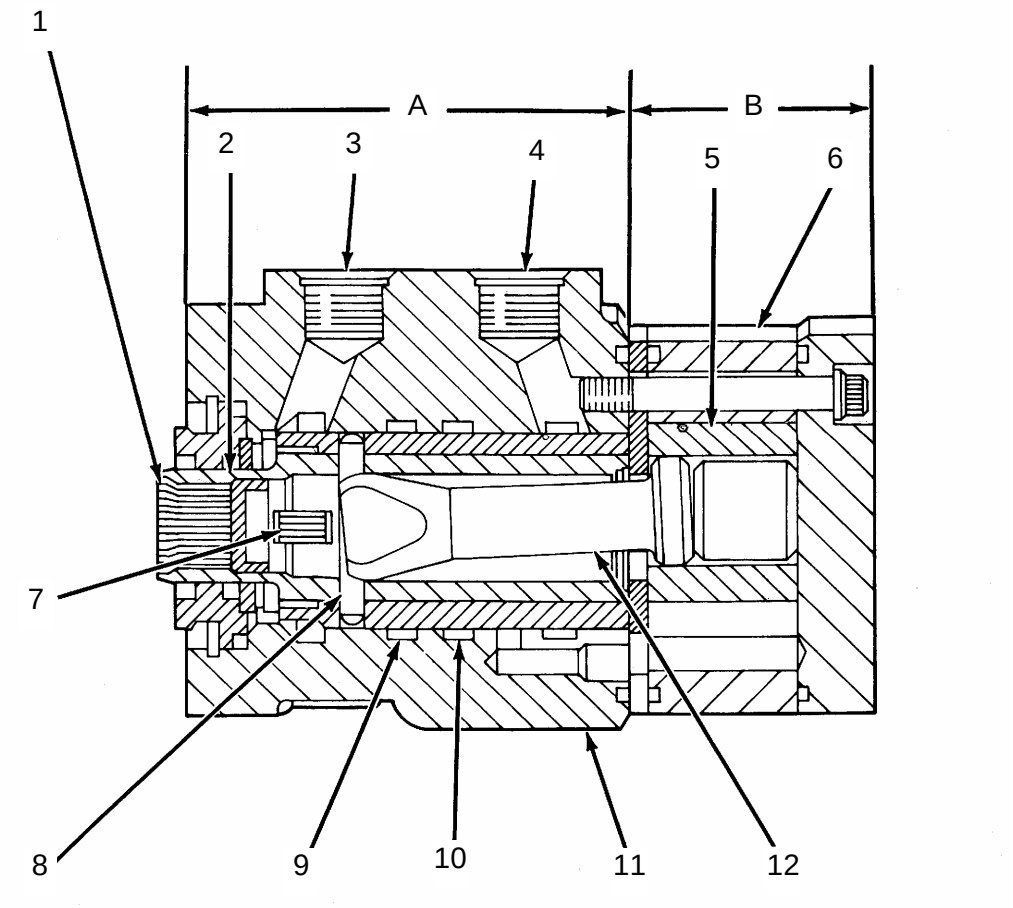
Steering Cylinder

Steering cylinder (1) gives power assistance through the use of pressure oil at either end of the cylinder piston.

The steering cylinder is double ended and the body of the cylinder is mounted stationary to the steer axle. The rod assembly is connected to the steering link assembles at both ends of the cylinder which allows the cylinder to move the link assemblies.



Steering Cylinder (Typical Example)
(1) Steering cylinder.



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Steering Gear
(1) Spool. (2) Sleeve. (3) Outlet (to tank). (4) Inlet (for pump oil). (5) Internal pump gear. (6) External pump gear. (7) Centering springs. (8) Pin. (9) Left turn port. (10) Right turn port. (11) Body. (12) Drive. (A) Control section. (B) Metering section.

Lift trucks use the load sensing, closed center (oil flow to steering gear only when needed) steering gear.

All lift truck hydraulic lines serve a dual purpose in that they serve both the steering and cylinder hydraulics through the use of a priority valve. The priority valve sends oil to the steering gear before the needs of the cylinder hydraulics are met.

The steering gear has two main sections: control section (A), and pump or metering section (B). These two sections work together to send oil to the steering cylinder.

Oil from the control valve goes through inlet (4) into the control section of the steering gear. When the steering wheel is turned, the control section sends the oil to and from the metering section and also to and from the steering cylinder.

The metering section is a small hydraulic pump. It controls (meters) the oil that goes to the steering cylinder. As the steering wheel is turned faster, there is an increase in the flow of oil to the steering cylinder. This increased flow causes the main valve spool to move farther. As the spool moves farther, more oil can flow from the priority valve or power steering pump to the steering cylinder, and a faster turn is made.

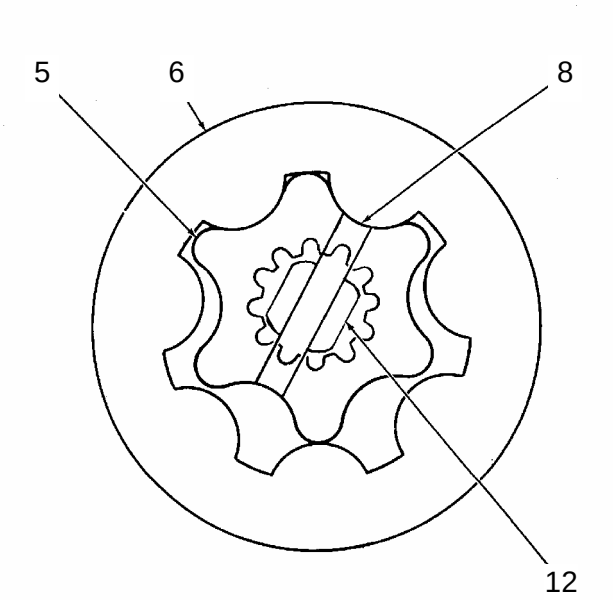
Oil Flow

The oil from the control valve flows through inlet (4). When the steering wheel is stationary (NEUTRAL), the oil is stopped by spool (1). The oil can not flow through the steering gear to the steering cylinder until the steering wheel is turned.

The steering wheel is connected to spool (1) by a shaft assembly and splines. When the steering wheel is turned, spool (1) turns a small amount until springs (7) are compressed. Then, sleeve (2) starts to turn. As long as the steering wheel is turned, the spool and sleeve both turn as a unit, but they turn a few degrees apart.

When the spool and sleeve are a few degrees apart, oil passages are opened between them. This lets the pump oil from inlet (4) flow through passages in body (11) to the metering section.

When the steering wheel is turned, pin (8) turns with the sleeve and causes drive (12) to turn also. The drive causes a rotation of gear (5) inside gear (6). This rotation of the gear sends a controlled (metered) flow of pilot oil back through body (11). This oil flows to port (9) or (10) and then to the steering cylinder. Port (9) or (10), that is not used for pressure oil to the steering cylinder, is used for return oil from the other end of the steering cylinder.



IDCS114S

Pump Gears In Metering Section
(5) Internal pump gear. (6) External pump gear. (8) Pin. (12) Drive.

If the steering wheel rotation is stopped, springs(7) will move sleeve(2) back in alignment with spool(1) (NEUTRAL position). This will close passages between the metering section and control section and the steering gear will be in the NEUTRAL position.

When the engine is off, the steering gear can be manually operated. The control section will work as a pump. The oil that is returned from the steering cylinder is not returned to the tank. The suction of the control section will open an internal check valve and let return oil from the steering cylinder go to the inlet side of the control section. During power operation, supply pressure keeps the check valve closed.

Brake Power Master Cylinder

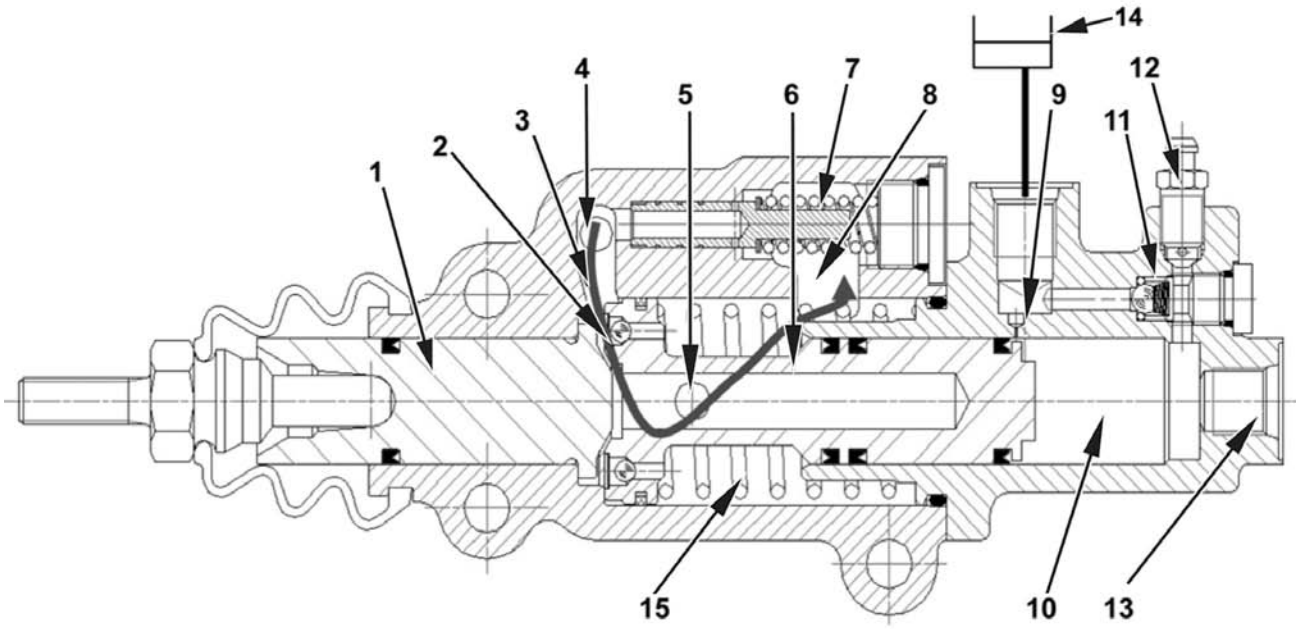


Fig 1: Master Cylinder Section View - Neutral

1. Master piston; 2. Flow passage; 3. Chamber; 4. “P” Port; 5. Passage; 6. Servo piston; 7. Relief valve; 8. Chamber (tank port); 9. Orifice; 10. Chamber; 11. Check valve; 12, Air bleeder; 13. Work port; 14. Brake oil reservoir 15. Spring

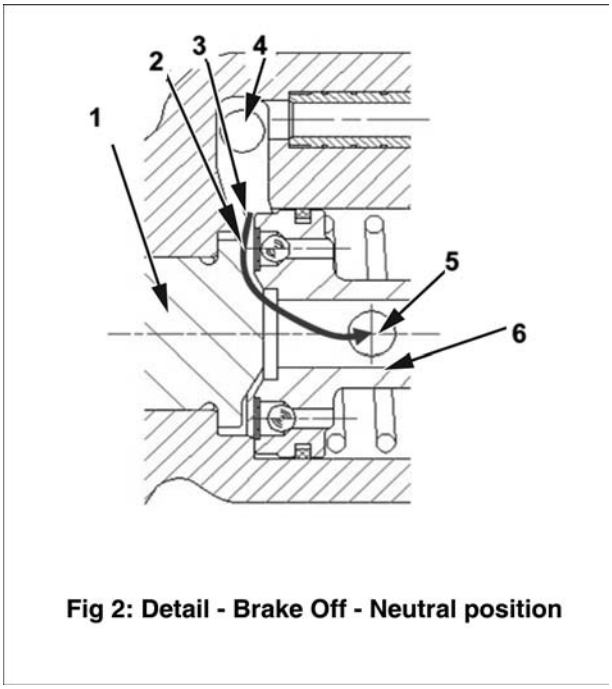


Fig 2: Detail - Brake Off - Neutral position

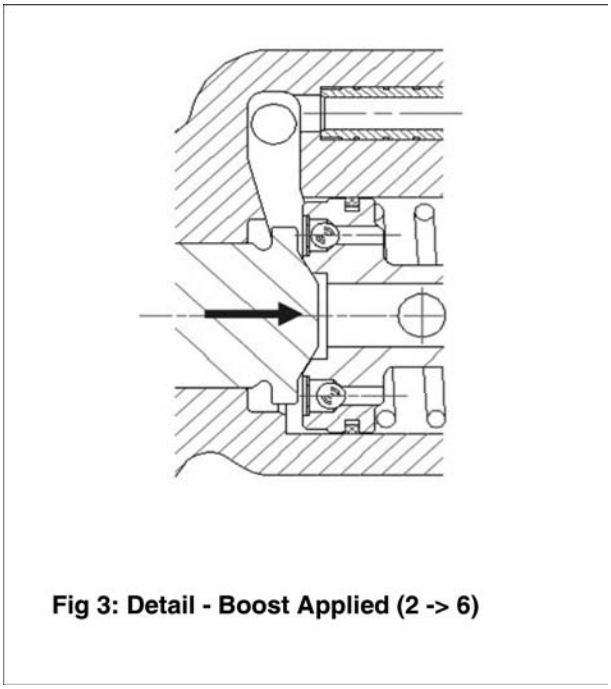


Fig 3: Detail - Boost Applied (2 -> 6)

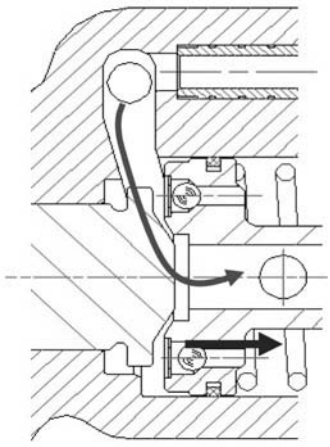


Fig 4: Detail - Boost Not Applied (2 -> 6)

The flow divider provides continual flow of 0.8 GPM through the brake spool to “P” port (4) of power master cylinder. When the brake pedal is not pushed (neutral position), the fluid goes through the flow passage (2) between the master piston (1) and servo piston (6), flow passage (5) and chamber (8), then returns to tank, as shown in Fig 1.

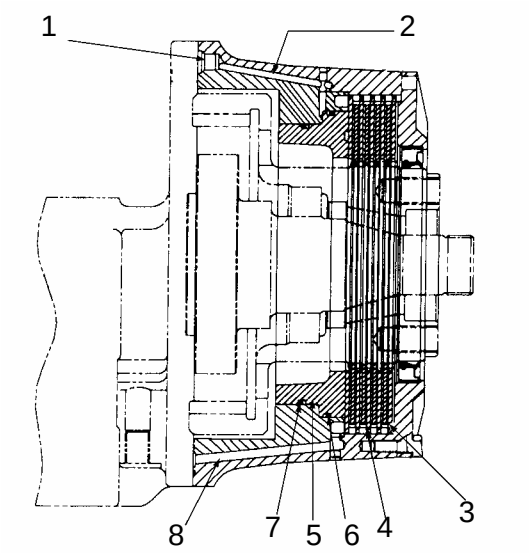
When the brake pedal is pushed, the master piston (1) advances toward the servo piston (6). Oil flowing through oil passage (2) is restricted and increases pressure in chamber (3) which pushes the servo piston more to the right. The master and servo pistons continue to move independently in reaction to the flow and pressure changes until a balance is reached where the force in chamber (3) equals the force working against servo piston in chamber (10) plus the reaction force of spring (15) and flow passage (2) is closed (ref: Fig 3 & Fig 4). Pressure then builds up to assist in brake application. The operator feels the feed-back force as pressure increases in chamber (3).

When the brake pedal is released, return spring (15) forces master piston (1) and a servo piston (6) to return to the initial position (or neutral position). As these pistons return, displaced oil within chamber (10) is replenished through check valve (11) from reservoir (14). When the pistons have moved past the replenishing orifice (9), pressure in chamber (10) drops to zero and oil from reservoir (14) can now pass through the orifice.

Relief valve (7) is built into the power master cylinder to prevent exceeding 40 bar (580 PSI) pressure within chamber (3). As pressure builds, the sleeve of the relief valve shifts and compresses the spring. This opens boost chamber (3) to drain chamber (8) preventing over-pressurizing the system. This limits excessive reaction force of the brake pedal.

In case of accidental engine shut down the system becomes mechanically operated. With no hydraulic boost the result is greater brake pedal force is required to stop the truck.

Oil Cooled Disc Brake



IDCS211-1S

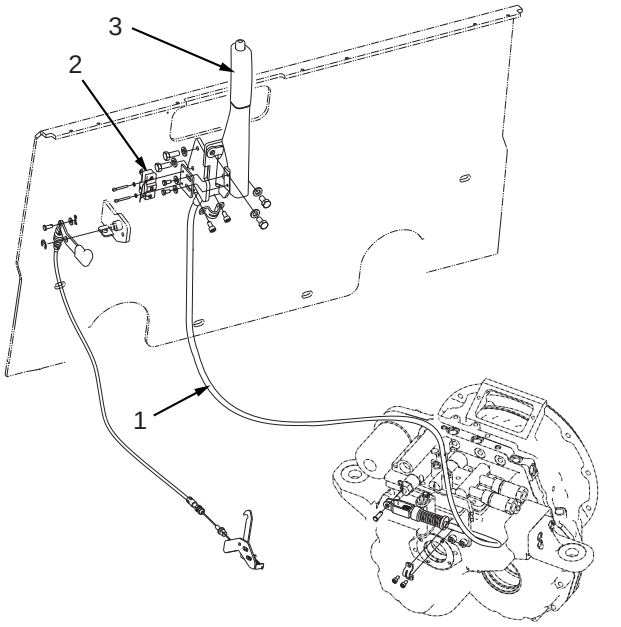
Disc Brake Assembly
(1) Inlet (from brake valve). (2) Passage. (3) Plates (five).
(4) Discs (four). (5) Piston. (6) Seal. (7) Seal.
(8) Passage (for cooling oil).

When the brake pedal is pushed down, the brake valve pushes brake liquid through the brake valve outlet, the brake lines, to inlet (1) of each disc brake assembly. Liquid flows through inlet (1), passage (2) and pushes on piston (5). Piston (5) pushes against plates (3) and friction discs (4) to stop any movement of the lift truck. The five separator plates (3) are splined to the wheel cover and the four friction discs (4) are splined to the hub. During brake activation the piston seals (6) and (7) are deflected by the brake piston movement.

When the brake pedal is released, the brake liquid pressure is released and seals (6) and (7) return to their original position. This seal retraction gives the running clearance needed between plates (3) and discs (4). This action will release the brakes on the lift truck. As the seals retract brake liquid is returned to the brake valve. The piston automatically slides outward from the cylinder bore as the friction discs wear. This new location then becomes the beginning or at rest position of the seals. This will maintain the proper clearances of the discs and plates.

When the brakes are activated, heat is generated by plates (3) and discs (4). Drive axle oil in a separate brake cooling circuit flows through passage (8) and cools the plates and discs during normal operation.

Parking Brake

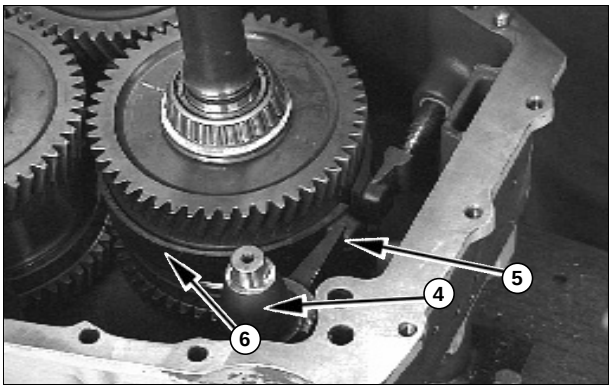


Parking Brake Linkage
(1) Cable Assembly. (2) Switch. (3) Lever.

The band-type parking brake is installed on the input shaft clutch pack inside the transmission. The parking brake control assembly is mounted on the cowl. The parking brake is controlled with a lever. The control lever is connected to the parking brake with a cable assembly (1).

The parking brake is activated when the control lever is pulled. When the operator pulls the control lever, cable assembly (1) pulls lever (3) which will turn cam and push strut (5). This will tighten brake band (6) on the input shaft clutch pack and stop any lift truck movement.

To prevent driving when the parking brake is activated (engaged) switch (2) is opened. This will put the transmission in neutral so the lift truck can not be driven.



Parking Brake
(4) Cam. (5) Strut. (6) Brake Band.

Delayed Engine Shutdown System

Operation

The delayed engine shutdown system will shut the engine down if no proper action is taken by the operator. This system makes use of the engine oil pressure switch, transmission oil temperature switch and water (coolant) temperature sensor to get the required truck condition.

If an engine damaging condition arises, such as too much oil pressure drop, this system will alert the operator by warning MIL Lamp.

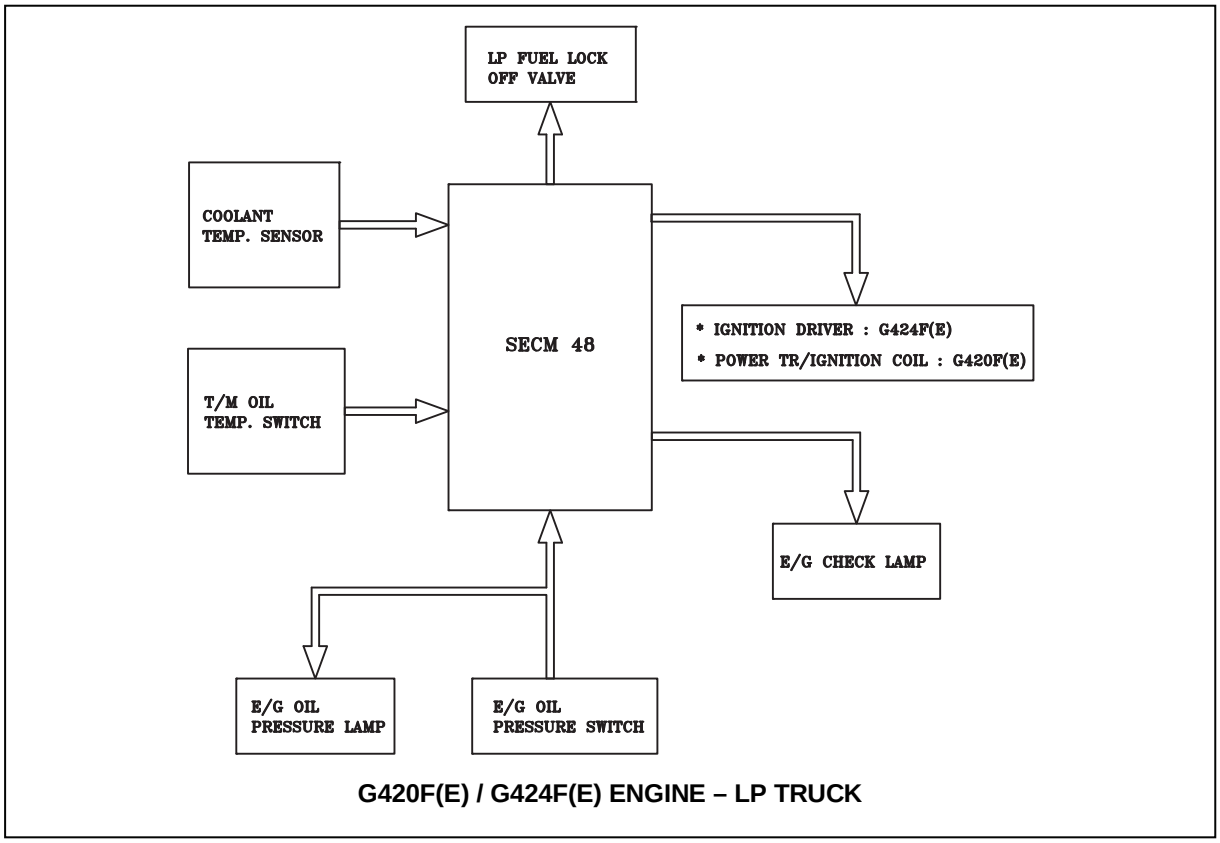
If the operator ignores this warning and does not shutdown the engine within thirty seconds, this delayed engine shutdown system will interrupt the fuel supply to the engine, thereby saving the engine from the critical damage.

1. Low engine oil pressure
The warning MIL lamp will turn on when the oil pressure drops to approximately 28KPa (4 psi) and the delayed engine shutdown system will interrupt the fuel supply to the engine after thirty seconds.

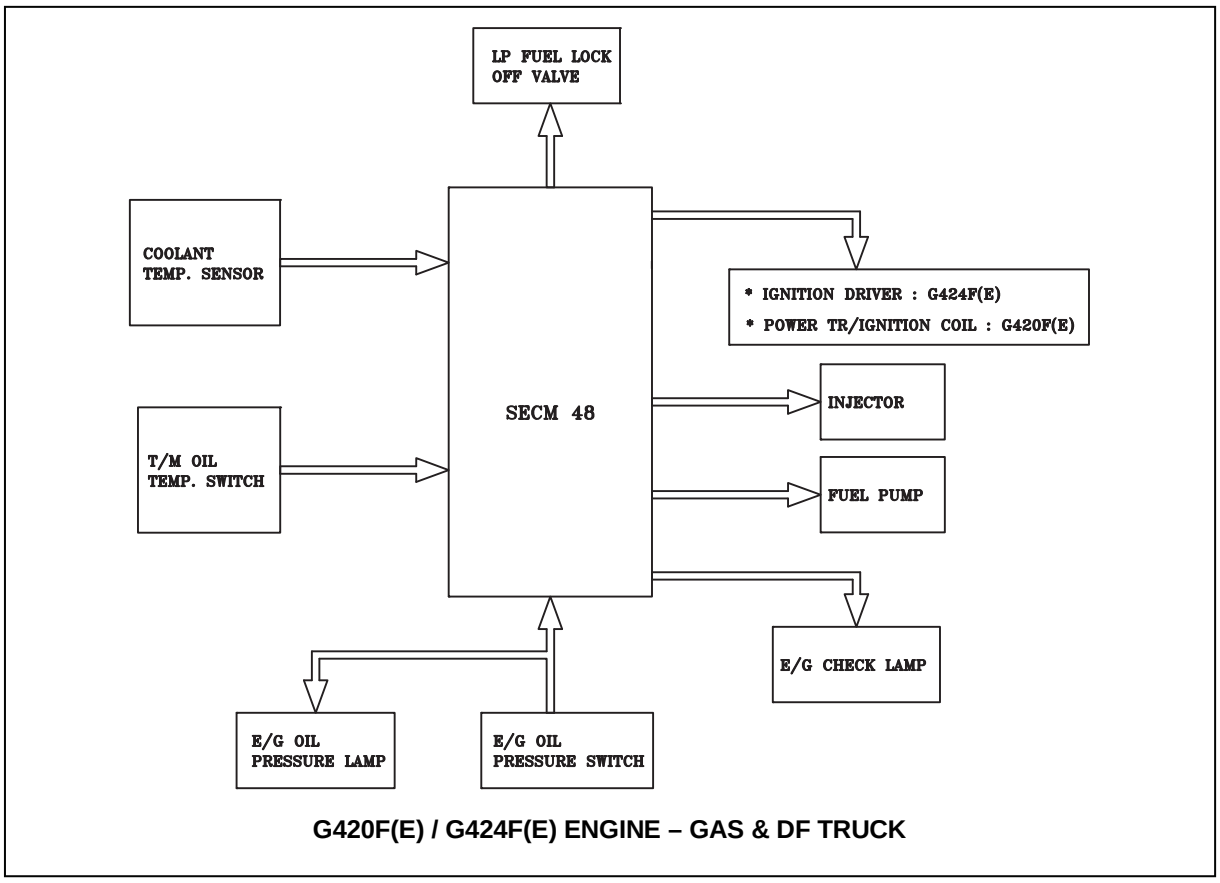
2. Hot engine coolant
The warning MIL lamp will turn on when the coolant temperature reaches approximately 115℃(239°F) and the delayed engine shutdown system will interrupt the fuel supply to the engine after thirty seconds.

3. Hot transmission oil
The warning MIL lamp will turn on when the transmission oil temperature reaches approximately 125℃(257°F) and the delayed engine shutdown system will interrupt the fuel supply to the engine after thirty seconds.

Diagram of Delayed Engine Shutdown System



G420F(E) / G424F(E) ENGINE – LP TRUCK



G420F(E) / G424F(E) ENGINE – GAS & DF TRUCK

Trouble shooting of Delayed Engine Shutdown System

When the ignition key is turned on, the MIL Lamp will illuminate and remain on until the engine is started. Once the engine is started, the MIL Lamp will go out unless one or more fault conditions are present. If a detected fault condition exists, the fault or faults will be stored in the memory of the small engine control module (SECM).

Once an active fault occurs, the MIL Lamp will illuminate and remain ON. This signals the operator that a fault has been detected by the SECM. If the MIL Lamp turns on while operating the lift truck, park the lift truck and stop the engine, and then check the follows.

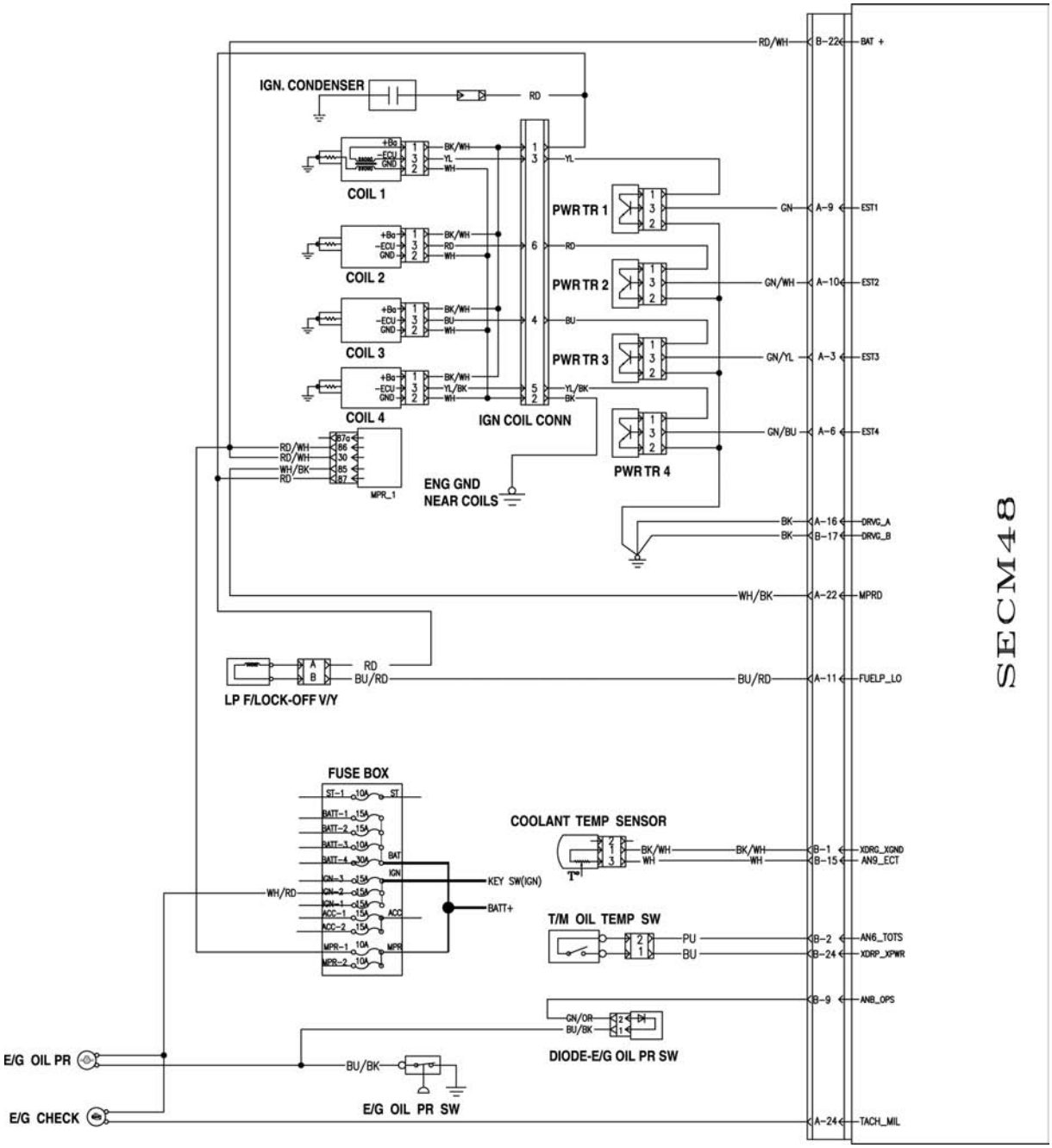
Delayed Engine shutdown : Some faults, such as low oil pressure, will cause the MIL Lamp to illuminate for 30 seconds and then shut down the engine

FAULT	DESCRIPTION	CODE (M104 CODE)
ECT Over Range High	Engine Coolant Temperature Sensor Input is High. Normally set if coolant sensor wire has been disconnected or circuit has opened to the SECM	151(15)
ECT Over Temperature Fault	Engine Coolant Temperature is High. The sensor has measured an excessive coolant temperature typically due to the engine overheating	161(15)
Low Oil Pressure Fault	Low engine oil pressure	521(52)
Transmission Oil Temperature	Excessive transmission oil temperature	933

Diagnostic Fault Codes

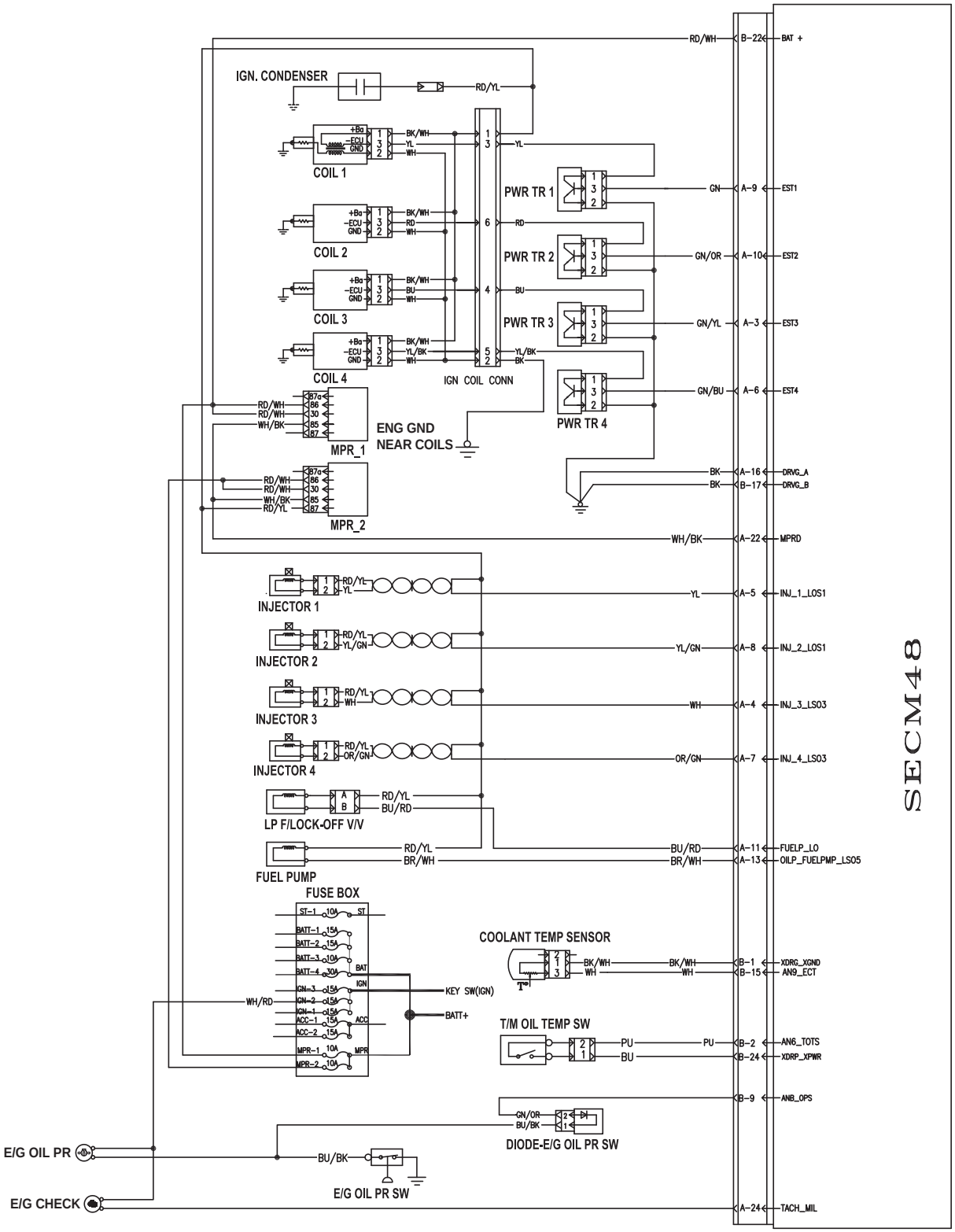
DFC	PROBABLE FAULT	FAULT ACTION	CORRECTIVE ACTION FIRST CHECK
151 (15)	ECT Range High Coolant sensor disconnected or open circuit	(1) Turn on MIL (2) Delayed Engine Shutdown (3) Check Engine Light	Check if ECT sensor connector is disconnected or for an open ECT circuit SECM (Signal) Pin B15 to ECT Pin 3 SECM (Sensor GND) Pin B1 to ECT Pin 1
161 (15)	ECT Over Temperature Fault Engine coolant temperature is high. The sensor has measured an excessive coolant temperature typically due to the engine overheating.	(1) Turn on MIL (2) Delayed Engine Shutdown (3) Check Engine Light	Check coolant system for radiator blockage, proper coolant level and for leaks in the system. Possible ECT short to GND, check ECT signal wiring SECM (Signal) Pin B15 to ECT pin 3 SECM (Sensor GND) pin B1 to ECT pin 1 SECM (System GND) pin A16, B 17 Check regulator for coolant leaks
521 (52)	Low Oil Pressure Fault Low engine oil pressure	(1) Turn on MIL (2) Delayed Engine Shutdown (3) Check Engine Light	Check engine oil level Check electrical connection to the oil pressure switch SECM Pin B9 to Oil Pressure Switch
933	Trans Oil Temperature Excessive Transmission oil temperature	(1) Turn on MIL (2) Delayed Engine Shutdown	Refer to drive train manufacturer's Transmission service procedures

Delayed Engine Shutdown System Schematic



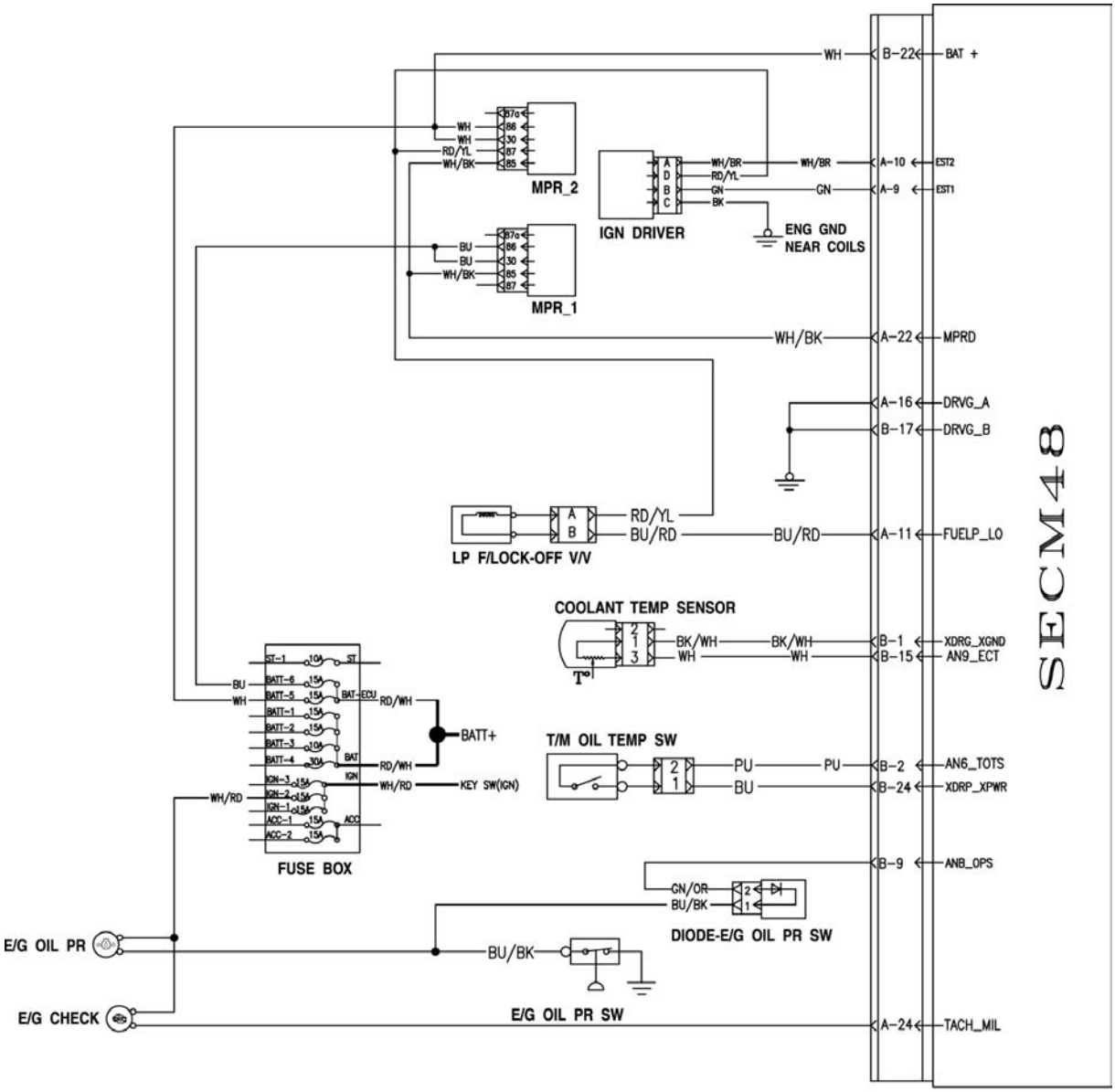
DELAYED ENGINE SHUTDOWN : G420F(E) - LP

Delayed Engine Shutdown System Schematic



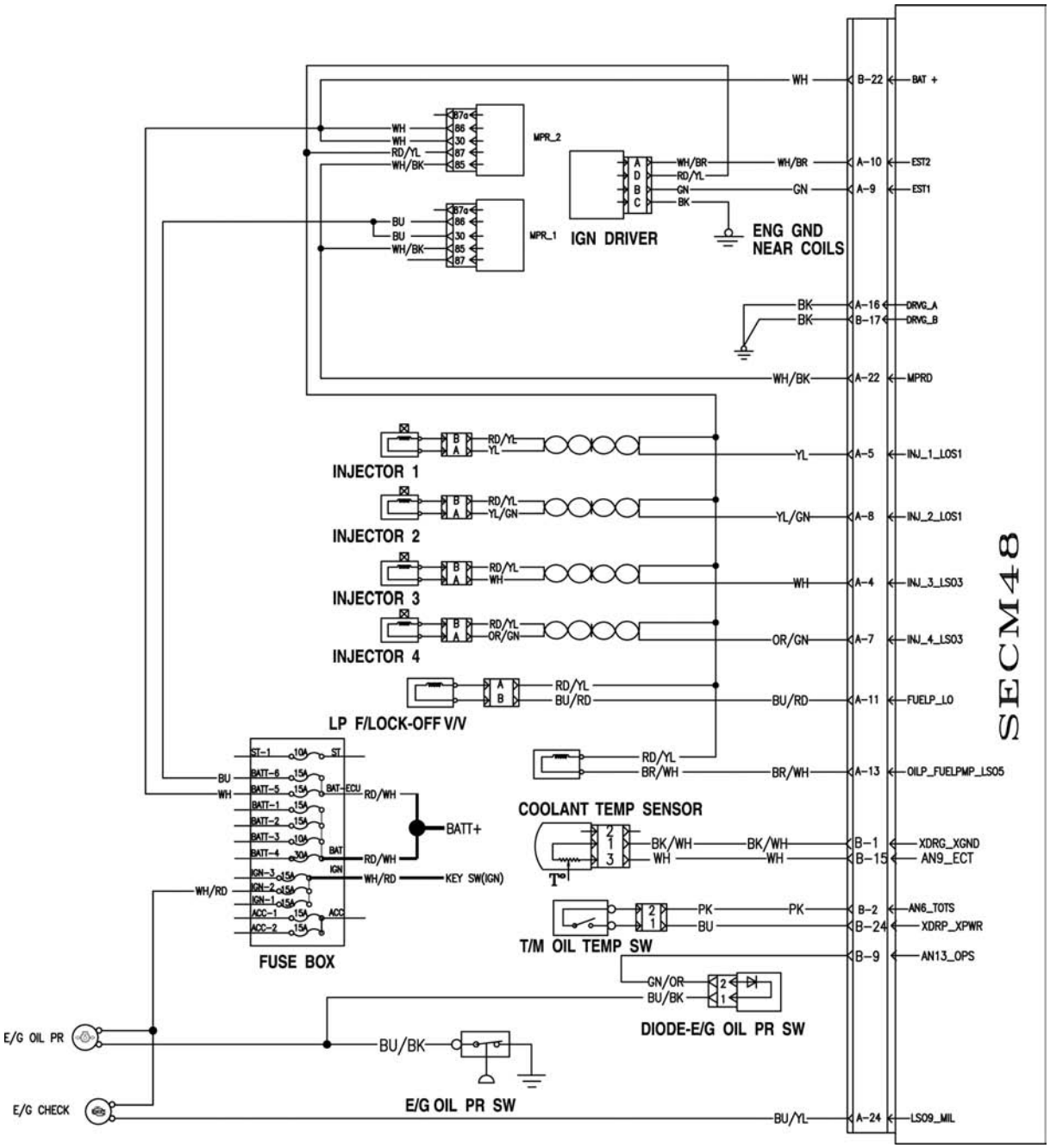
DELAYED ENGINE SHUTDOWN : G420F(E) - GAS&DF

Delayed Engine Shutdown System Schematic



DELAYED ENGINE SHUTDOWN : G424F(E) - LP

Delayed Engine Shutdown System Schematic



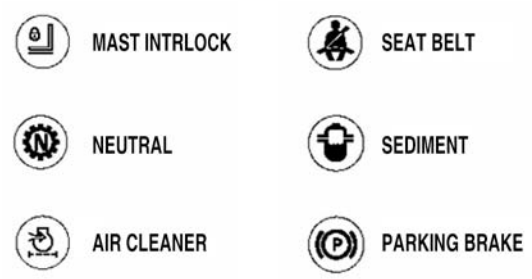
DELAYED ENGINE SHUTDOWN : G424F(E) - GAS&DF

OSS (Operator Sensing System)

Operation

Operator Sensing System is operated by seat switch built into the seat. If the operator leaves the seat without applying the parking brake within three seconds after leaving the seat, Operator Sensing System will automatically disengage the transmission and interrupt the operation of mast. In addition, the warning lamp and buzzer are operated in order to prevent the unintentional movement.

Symbols of OSS



1. Parking alarm
Alarm warning lights when the operator leaves the seat without applying parking brake.

2. Seat belt indicator
Seat belt warning lights for 10 seconds reminds the operator to fasten seat belt.
The truck is normally operated although warning lamp is turned on.

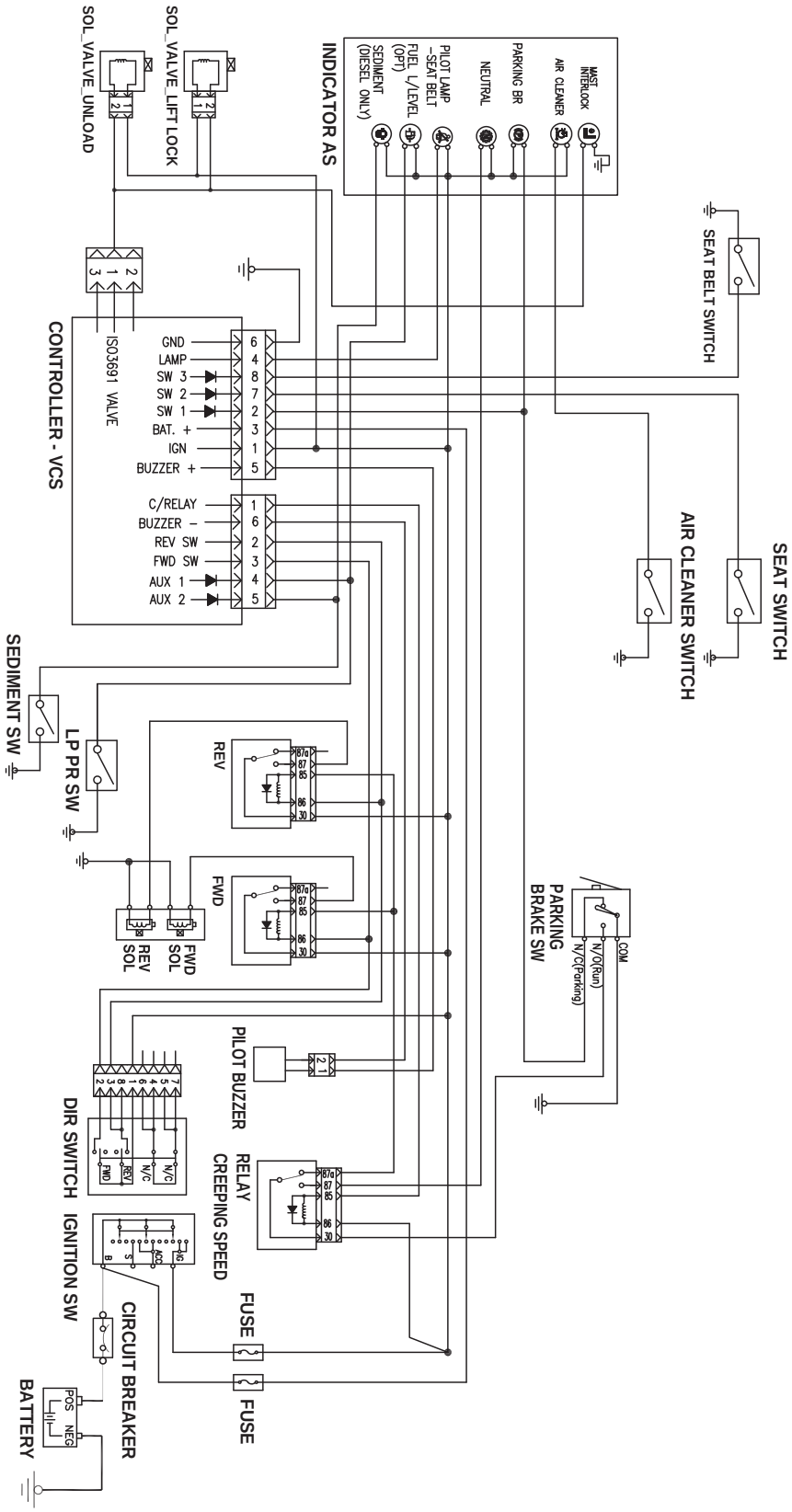
3. Neutral shift feature
Transmission is automatically shifted to the neutral when the operator leaves the seat with the engine running and the direction lever in forward or reverse. To restore the lift truck, return the directional lever to the neutral position and then, reselect a direction of travel (either forward or reverse). The transmission will then re-engage.

4. Water separator (sediment) warning – only diesel
Water separator lamp indicates when the engine is running and there is much water in the fuel filter exceeding 100cc.
If the lamp turns on with the engine running, park the lift truck and stop the engine. Drain some fuel (and any water) until clean fuel flows from the filter which approximately takes 5 to 6 seconds.

5. Mast interlock
Alarm warning lights when operator leaves the seat without applying parking brake and then, operation of mast is automatically interrupted .

6. Air cleaner warning
Alarm warning lights if the dust is chock – full at the air clean.

Operator Sensing System Schematic



Trouble shooting of Operator Sensing System

CONDITION	PROBABLE FAULT	CORRECTIVE ACTION
1. Buzzer warning 2. Parking brake light	1. Seat switch open 2. Parking brake switch open 3. Controller defect 4. Wiring defect	1. Check seat switch 2. Check parking brake switch 3. Check continuity of wire from seat switch to controller (SW2) 4. Measure the voltage between controller(SW2) and GND : 12V is no problem
1. Seat belt warning light	1. Seat switch open 2. Controller defect 3. Wiring defect	1. Check seat switch 2. Check continuity of wire from seat belt switch to controller (SW3) 3. Measure the voltage between controller(SW3) and GND : 12V is no problem
1. Buzzer warning 2. Neutral light 3. No drive operation	1. Seat switch open 2. Relay (REV/FWD/Creep speed) defect 3. Directional switch defect 4. Wiring defect 5. FWD/REV Solenoid defect 6. Controller defect	1. Check seat switch 2. Check relay (REV/FWD/Creep speed) 3. Check FWD/REV Solenoid 4. Check continuity of wire from relay creeping speed (85) to controller (C/RELAY) 5. Check continuity of wire from relay-REV(86)or Dir SW(3) to controller (REW SW) 6. Check continuity of wire from relay-FWD(86)or Dir SW(2) to controller (FWD SW)
1. Buzzer warning 2. Water separator warning light	1. Sediment switch short 2. Wiring defect 3. Controller defect	1. Check sediment switch 2. Check continuity of wire from sediment switch to controller (AUX2) 3. Measure the voltage between controller(AUX2) and GND : 12V is no problem

CONDITION	PROBABLE FAULT	CORRECTIVE ACTION
1. Buzzer warning 2. Mast interrupt light 3. No mast operation	1. Seat switch open 2. Fift lock / Unload solenoid defect 3. Wiring defect 4. Controller defect	1. Check seat switch 2. Check Lift lock/Unload Solenoid 3. Check continuity of wire from solenoid-lift lock(2) or solenoid-unload(2) to controller (ISO3691 VALVE) 4. Check continuity of wire from solenoid-lift lock(1) or solenoid-unload(1) to controller (IGN) 5. Measure the voltage between controller(IGN) and controller(ISO3691 VALVE) : 12V is no problem
1. Air cleaner light	1. Air cleaner switch short 2. Wiring defect	1. Check air cleaner switch 2. Check continuity of wire from air cleaner switch to air cleaner lamp

Testing and Adjusting

Troubleshooting

Troubleshooting can be difficult. A list of possible problems and corrections are on the pages that follow.

This list of problems and corrections will only give an indication of where a problem can be and what repairs are needed. Normally, more or other repair work is needed beyond the recommendations on the list. Remember that a problem is not necessarily caused only by one part, but by the relation of one part with other parts. This list can not give all possible problems and corrections. The serviceman must find the problem and its source, then make the necessary repairs.

Tools needed	
Fittings Group	1

The Fitting Group is used to make the pressure tests of the hydraulic system. Before any test is made, visually inspect the complete hydraulic system for leakage of oil and for parts that have damage.

⚠ WARNING

To prevent personal injury when testing and adjusting the hydraulic system, move the machine to a smooth horizontal location and lower the mast and carriage to the ground, make sure they are blocked correctly to keep them from a fall that is not expected. Move away from machines and personnel that are at work. There must be only one operator. Keep all other personnel away from the machine or where the operator can see the other personnel.

Before any hydraulic pressure plug, line or component is removed, make sure all hydraulic pressure is released.

Visual Checks

A visual inspection of the hydraulic system and its components is the first step when a diagnosis of a problem is made. Lower the carriage to the floor and follow these inspections;

1. Measure the oil level. Look for air bubbles in the oil tank.

2. Remove the filter element and look for particles removed from the oil by the filter element. A magnet will separate ferrous particles from nonferrous particles (piston rings, O-ring seals, etc.).

3. Check all oil lines and connections for damage or leaks.

4. Check all the lift chains and the mast and carriage welds for wear or damage.

Performance Test

The performance tests can be used to find leakage in the system. They can also be used to find a bad valve or pump. The speed of rod movement when the cylinders move can be used to check the condition of the cylinders and the pump.

Lift, lower, tilt forward and tilt back the forks several times.

1. Watch the cylinders as they are extended and retracted. Movement must be smooth and regular.

2. Listen for noise from the pump.

3. Listen for the sound of the relief valve. It must not open except when the cylinders are fully extended or retracted without load on forks.

Hydraulic Oil Temperature (Too Hot)

When the temperature of the hydraulic oil gets over 98.8°C (210°F), polyurethane seals in the system start to fail. High oil temperature causes seal failure to become more rapid. There are many reasons why the temperature of the oil will get this hot.

1. Hydraulic pump is badly worn.

2. Heavy hydraulic loads that cause the relief valve to open.

3. The setting on the relief valve is too low.

4. Too many restrictions in the system.

5. Hydraulic oil level in the tank is too low.

6. High Pressure oil leak in one or more circuits.

7. Very dirty oil.

8. Air in the hydraulic oil.

NOTE : If the problem is because of air in the oil, it must be corrected before the system will operate at normal temperatures. There are two things that cause air in the oil (aeration). These are:

a. Return oil to the tank goes in above the level of the oil in the tank.

b. Air leaks in the oil suction line between the pump and the tank.

Hydraulic System and Mast

During a diagnosis of the hydraulic system, remember that correct oil flow and pressure are necessary for correct operation. The output of the pump (oil flow) increases with an increase in motor speed (rpm) and decreases when motor speed (rpm) is decreased. Oil pressure is caused by resistance to the flow of oil.

Visual checks and measurements are the first step when troubleshooting a possible problem. Then do the Operation Checks and finally, do instrument tests with pressure gauges.

Use the Fittings Gauge, a stop watch, a magnet, a thermometer and a mm (inch) ruler for basic tests to measure:

1. The pressure of the oil to open the relief valve. Relief valve pressures that are too low will cause a decrease in the lift and the tilt characteristics of the lift truck. Pressures that are too high will cause a decrease in the life of hoses and components.

2. Drift rates in the cylinders. Cylinder drift is caused by a leakage past cylinder pistons, O-ring seals in the control valve, check valves that do not seat correctly or poor adjustment or fit in the control valve spools.

3. Cycle times in the lift and tilt circuits: Cycle times that are too long are the result of leakage, pump wear and/or pump speed (rpm).

Hydraulic System and Mast

Problem: The hydraulic system will not lift the load.

Probable Hydraulic Cause:

1. There is an air leak, which lets air into the hydraulic system on the inlet side of the hydraulic pump.

2. The relief valve opens at low oil pressure.

3. The hydraulic pump has too much wear.

4. The priority valve does not work correctly.

5. The load is not correct.

6. Unload function doesn't work correctly.

Probable Mechanical Cause:

1. The mast is not in alignment with the other lifting components and does not move freely.

2. Not enough lubricant on the parts of the mast that move.

3. The carriage or mast rollers bearings are worn and do not move (seized).

4. Mast shimmed too tight.

Problem: Lift cylinder extends too slowly.

Probable Hydraulic Cause:

1. Not enough oil supply to lift cylinder.

2. Defective lift cylinder seals.

3. Relif pressure ser too low.

4. Unload function doesn't work correctly.

Problem: Mast does not move smoothly.

Probable Hydraulic Cause:

1. Air in the hydraulic system.

2. Relief valve sticks or defective.

3. Damaged cylinders.

Probable Mechanical Cause:

1. Not enough lubricant on the parts of the mast that move.

2. Load rollers defective or not adjusted correctly.

3. Mast rollers not shimmed correctly.

4. Mast assembly is damaged or not in alignment.

Problem: The mast does not tilt correctly or moves too slowly.

Problem Hydraulic Cause:

1. There is a restriction in the hydraulic tilt lines.

2. There is an air leak, which lets air into the hydraulic system on the inlet side of the hydraulic pump.

3. The relief valve opens at low oil pressure.

4. The hydraulic pump has too much wear.

5. The internal valve of the tilt spool is stuck

6. Control valve tilt spool has a restriction

7. The priority valve does not work correctly.

8. Seals in tilt cylinder worn or damaged.

9. Unload function doesn't work correctly.

Provable Mechanical Cause:

1. Damage or failure of the tilt cylinders.

2. Mast mounting pins seized.

Problem: The carriage will not lower correctly.

Safety lift lock function: Once the operator leaves a seat more than 3 seconds or a start key is off, the lift cylinder doesn't lower even though lift lever is pulled for lowering. If the operator is seated or, a key is on, the lowering will normally work immediately.

Probable Hydraulic Cause:

1. The electric switch (on-off) below a seat got damaged.

2. The electric parts (relay and controller) related to a solenoid valve in lift section of control valve got failed.

Probable Mechanical Cause:

1.Lift poppet (lift lock) damaged and contaminated.

2. Needle valve is loosened.

Problem: The lift or tilt cylinders do not hold their position with the valve control levers in neutral position.

Probable Cause:

1. The valve spools do not hold their positions because the springs for the valve spools are weak or broken.

2. Control valve leakage caused by worn valve spools or seals.

3. The check valves in the control valve are defective.

4. Leakage of the cylinder lines or piston seals.

5. There is foreign material in the control valve.

Hydraulic Pump

Problem: Noise in the pump.

Probable Cause:

1. The oil level is low.

2. The oil is thick (viscosity too high) or seals..

3. The pump inlet line has a restriction in it (strainer plugged).

4. Worn parts in the pump.

5. Oil is dirty.

6. Air leaks into the inlet line.

Problem: The oil temperature is too high.

Probable Cause:

1. The oil level is low.

2. There is a restriction in an oil passage.

3. The relief valve setting is too low.

4. The oil is too thin.

5. There is air leakage in the system.

6. The pump has too much wear.

7. The system operates at too high a pressure.

a. Relief valve setting too high.

b. Attachment components cause a restriction during movement.

c. Restrictions in flow control valve, load check valve and in oil lines.

8. Severe hydraulic usage.

Problem: Leakage at the pump shaft seal.

Probable Cause:

1. The shaft seal is worn.

2. There is a broken gasket behind the seal.

3. The inner parts of the pump body are worn.

4. Operation with too low oil level in tank causes suction on the seal.

5. Seal cut on shoulder of pump or keyway during installation.

6. Seal lips are dry and hardened from heat.

Problem: There is a failure pump to deliver the fluid.

Probable Cause:

1. Low level of the oil in the tank.

2. There is a restriction in the pump inlet line.

3. There is air leakage in the pump inlet line.

4. The viscosity of the oil is wrong.

5. The pump has too much wear.

6. Failure of the pump shaft or coupling.

7. The bolts of the pump do not have the correct torque.

8. Filter by-pass not working or installed backwards.

Hydraulic Control Valve

Problem: The control spools do not move freely.

Probable Cause:

1. The temperature of the oil is too high.

2. There is foreign material in the fluid.

3. The fitting connections in the valve body are too tight.

4. The mounting bolts of the valve assembly do not have the correct torque and have twisted the body.

5. Linkage of the lift and tilt levers does not operate smoothly.

6. Bent lift or tilt spools.

7. Damage to the return springs of the spools.

8. The valve is not at normal temperature for operation.

Problem: Control valve spools have leakage around the seal.

Probable Cause:

1. There is some foreign material under the seal.

2. The valve spools are worn.

3. The seal plates are loose.

4. The seals have damage or are badly worn.

Problem: The load lowers when the lift spool is moved from the neutra position to the raise position.

Probable Cause:

1. There is some foreign material in the load check valve area.

2. The load check valve and seat show wear.

3. Sudden loss of pump oil pressure.

4. Damage to the relief valve which causes low oil pressure.

Problem: Spools do not return to neutral.

Probable Cause:

1. The springs are broken.

2. The spool is bent.

3. The system or valve has foreign particles in it.

4. The control linkage is not in alignment.

5. The fastening bolts of the valve have too much torque.

Problem: No motion or slow, then a too sudden action of the hydraulic system.

Probable Cause:

1. The relief valve is not correctly set, or will not move in base and/or is worn.

2. There is air in the system.

3. Dirt or foreign particles between relief valve control poppet and its seat.

4. Valve body has a crack inside.

5. Spool not moved to a full stroke.

Lift and Tilt Cylinders

Problem: Leakage around the cylinder rod.

Probable Cause:

1. Cylinder head (bearing) seals are worn.

2. Cylinder rod is worn, scratched or bent.

Problem: There is leakage of oil inside the cylinder or loss of lift or tilt power.

Probable Cause:

1. The piston seals are worn and let oil go through.

2. Cylinder has damage.

Problem: The piston rods show wear.

Probable Cause:

1. The cylinders are not in correct alignment.

2. Oil is dirty.

Problem: Foreign material behind the wiper rings causing scratches on the cylinder rod.

Probable Cause:

1. The wiper rings show wear and do not remove dirt and foreign material.

Steering System

Problem: Too much force needed to turn steering wheel.

Probable Cause:

1. Priority valve releases pressure oil at a low setting.

2. Pump oil pressure is low, worn pump.

3. Steering gear covers are too tight.

4. Steering column not aligned with steering gear.

5. Priority valve spool is held in one position.

6. Steering gear without lubrication.

7. Low fluid level in the hydraulic supply tank.

8. Steer axle damaged.

9. Worn steer cylinder piston seal.

Problem: Steering wheel does not return to center position correctly.

Probable Cause:

1. Steering gear covers are too tight.

2. Steering column is not in correct alignment.

3. Valve spool in the steering gear has a restriction.

4. Priority valve check valve permits lift and tilt hydraulic oil to affect steering hydraulic circuit.

Problem: Oil leakage at the pump.

Probable Cause:

1. Loose hose connections.

2. Detective shaft seal.

Problem: Low oil pressure.

Probable Cause:

1. Low oil level.

2. Priority valve relief valve spring weak.

3. Relief valve (priority valve) will not move from the Open position.

4. Oil leakage inside or outside of the system.

5. Defective pump.

Problem: Pump makes noise and the steering cylinder rod does not move smoothly.

Probable Cause:

1. Air in the steering hydraulic circuit.

2. The pump has too much wear.

3. Loose connection of the oil line on the inlet side of the pump.

4. The viscosity of the oil is wrong.

5. The oil level in the hydraulic tank is low.

6. Worn steer cylinder piston seal.

Problem: Lift truck does not turn when steering wheel is slowly turned.

Probable Cause:

1. The oil level of the tank is low.

2. There is air in the steering system.

3. The pump operation is not correct.

4. Dirt in the steering system.

5. Steering gear operation is not correct.

6. Steering cylinder has worn parts.

7. Restriction in the steer axle linkage.

Problem: The temperature of the oil is too hot.

Probable Cause:

1. The viscosity of the oil is wrong.

2. Air mixed with the oil.

3. The relief valve is set too high (priority valve).

4. There is a restriction in the line circuit.

5. Unit being held in relief mode for long periods of time.

Power Master Cylinder

Problem: Low power braking pressure or loss of power braking

Probable Cause:

1. Insufficient pedal stroke.

2. Lines connected to wrong ports.

3. Insufficient brake flow from the first section of control valve due to a stuck brake spool.

4. Relief valve in brake valve damaged.

5. Seals of servo piston in brake valve got damaged.

Problem: Low manual braking pressure or loss of manual braking

Probable Cause:

1. Insufficient pedal stroke.

2. Air in lines.

3. Damaged servo piston seals and sleeve due to contamination.

Problem: Pedal instability

Probable Cause:

1. Air in lines.

2. Damaged a check valve of brake port in the first section of control valve.

3. Damaged a spring of relief valve in brake valve.

4. Damaged a spring for brake spool in the first section of control valve.

Problem: External leakage

Probable Cause:

1. Damaged master piston or seal of master piston.

2. Casting porosity.

3. Fitting or line leakage.

Brake System

NOTE: If excessive force is applied to the brake pedal, the pedal can be forced to the end of the stroke. This is normal and should not be interpreted as a problem.

Problem: Pedal resistance is not solid (spongy) (under normal pedal pressure).

Probable Cause:

1. Air in the brake hydraulic system.

2. Brake valve is loose.

3. Servo piston seals worn or defective in brake valve.

4. Piston seals worn or defective in drive axle brake.

5. Low oil level of reservoir.

Problem: Extra (excessive) pedal travel (under normal pedal pressure).

Probable Cause:

1. Pedal adjustment is not correct.

2. Air in the brake hydraulic system.

3. Brake valve is loose.

4. Servo piston seals worn or defective in brake valve.

5. Low oil level of reservoir.

6. Piston seals worn or defective in drive axle brake.

Problem: Brake will not make application.

Probable Cause:

1. Low oil level of reservoir of brake valve.

2. Air in the brake hydraulic system.

3. Linkage adjustment is incorrect or bent.

4. Defective brake valve.

5. Bent plates or discs in drive axle brake.

6. Piston seals worn or defective in drive axle brake.

Problem: Hard pedal.

Probable Cause:

1. Mechanical resistance at pedal or disc assembly.

2. Restriction in the brake line.

3. Defective brake valve.

4. Brake discs look like glass (glazed) or are worn.

Problem: Both brake disc assemblies will not release all the way (drag).

Probable Cause:

1. Brake disc assemblies defective (stuck pistons).

2. Brake disc uneven (out of flat).

3. Restriction in the brake line.

4. Defective brake valve.

Problem: Brakes will not make application after being bled.

Probable Cause:

1. Leak in hydraulic line or connection.

2. Damaged seals in the brake valve.

Problem: Brake oil low in master cylinder reservoir, fluid must be added frequently.

Probable Cause:

1. Leak in hydraulic line or connection.

2. Damaged seals in the brake valve.

3. Leak in the disc assemblies.

Parking Brakes

Problem: Brake will not make application.

Probable Cause :

1. Parking brake assembly is out of adjustment.

2. Parking brake control cable is out of adjustment.

3. Worn brake band.

Hydraulic System

Relief Valve Pressure Check

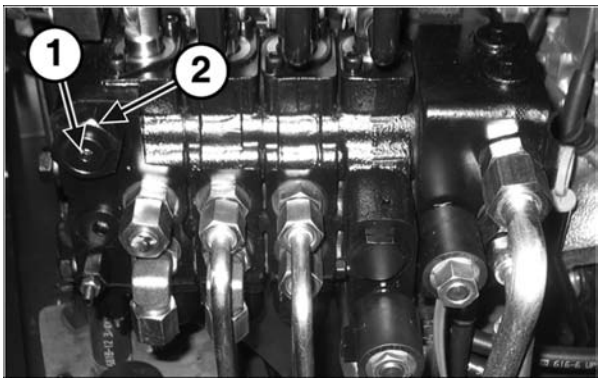
Tools Needed
Fittings Group

CONTROL VALVE		
D20S-5 G20E-5 G20P-5 GC20E-5 GC20P-5	18,100 ± 350 Kpa 2,625 ± 50 psi	15,500 ± 350 Kpa 2,250 ± 50 psi
D25S-5 G25E-5 G25P-5 GC25E-5 GC25P-5	19,500 ± 350 Kpa 2,825 ± 50 psi	15,500 ± 350 Kpa 2,250 ± 50 psi
D30S-5 G30E-5 G30P-5 GC30E-5 GC30P-5 G32E-5 G32P-5	21,550 ± 350 Kpa 3,125 ± 50 psi	15,500 ± 350 Kpa 2,250 ± 50 psi
D33SC-5 D35SC-5 G33P-5 G35P-5	24,000 (+500,-0) Kpa 3,490 (+75,-0) psi	15,500 ± 350 Kpa 2,250 ± 50 psi

Use the Fittings Group to check the relief valve pressure.

⚠ WARNING

Hydraulic oil, under pressure can remain in the hydraulic system after the engine and pump have been stopped. Personal injury can be caused if this pressure is not released before any work is done on the hydraulic system. To prevent possible injury, lower the carriage to the ground, turn the engine off and move the control levers to make sure all hydraulic pressure is released before any fitting, plug, hose or component is loosened, tightened, removed or adjusted. Always move the lift truck to a clean and level location away from the travel of other machines. Be sure that other personnel are not near the machine when the engine is running and tests or adjustments are made.



(1) gage plug (PF 1/2 thread) (2) Nipple assembly

With the engine off, remove the gage plug from nipple assembly (2) and connect the 28,000 KPa (4000 psi) gauge to the nipple assembly.

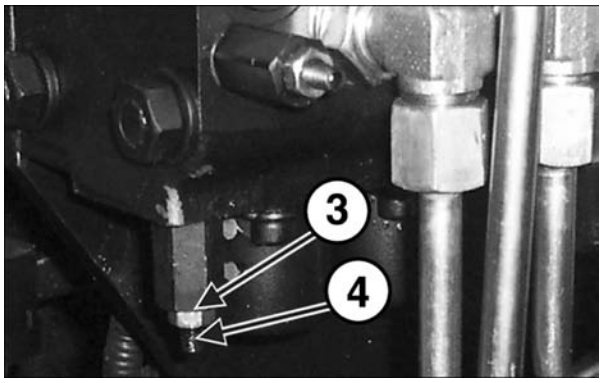
Lift Relief Valve Check and Adjustment

1. Start the engine and activate the hydraulics until the hydraulic oil is at the normal operating temperature.

2. Lift mast to maximum fork height without load on forks. Increase engine rpm to high idle. Hold the lift control lever in the lifting position and watch the gauge. The gauge indication is the pressure that opens the relief valve at the end of lift cylinder stroke.

Caution: Make sure there is adequate ceiling height. Lift cylinder must be fully extended. Mast should be in the vertical position and truck parked on level ground.

3. The correct pressure setting is shown in the chart.



Relief Valve Adjustment.
(3) Lock Nut. (4) Stud.

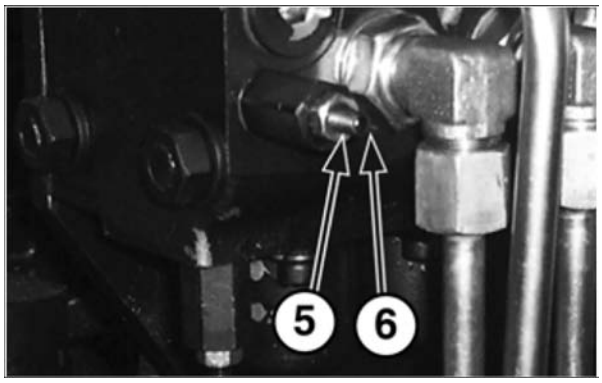
Tilt and Sideshift Relief Valve Check and Adjustment

1. Start the engine and activate the hydraulics until the hydraulic oil is at the normal operating temperature. Put the mast in the full tilt back position.

2. With the engine at high idle, hold the tilt control lever in the full tilt back position and watch the gauge. The gauge indication is the pressure that opens the relief valve.

3. The correct pressure setting is shown in the chart.

4. If an adjustment to the relief valve setting is necessary, loosen nut (5).



Relief Valve Adjustment
(5) Locknut. (6) Stud.

5. Turn setscrew (6) clockwise to increase or counterclockwise to decrease the pressure setting of the relief valve.

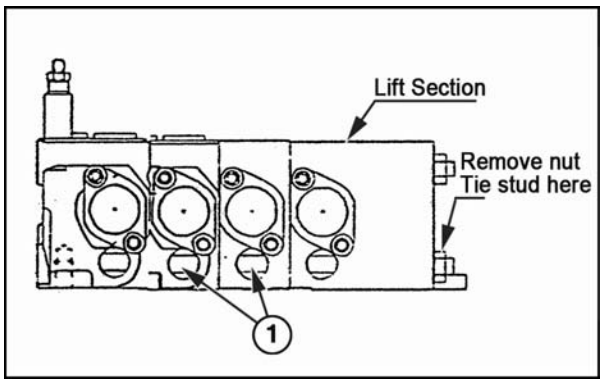
6. Tighten the locknut and check the pressure setting again for correct adjustment.

Flow Control Valve Adjustment

The tilt and first attachment speeds can be adjusted at the control valves. They can be adjusted by turning the plug in the hydraulic control valve body. The lift speed can not be adjusted. Do the procedure that follows to change the flow control assembly.

⚠ WARNING

Hydraulic oil, under pressure can remain in the hydraulic system after the engine and pump have been stopped. Personal injury can be caused if this pressure is not released before any work is done on the hydraulic system. To prevent possible injury, lower the carriage to the ground, turn the engine off and move the control levers to make sure all hydraulic pressure is released before any fitting, plug, hose or component is loosened, tightened, removed or adjusted. Always move the lift truck to a clean and level location away from the travel of other machines. Be sure that other personnel are not near the machine when the engine is running and tests or adjustments are made.



1. Remove the nut from the slotted tie-stud of main hydraulic valve

2. Remove the slotted tie-stud from the valve.

3. Use Hex Wrench (6mm or 1/4 inch), turn the flow control adjuster (1) clockwise to increase the flow or counterclockwise to decrease the flow.

4. Assemble the tie stud in the valve. Torque the stud to 40.5 ± 2.5 N·m (360 ± 24 lb·in)

5. Reinstall the nut on the tie bolt.

Standard Lift Cylinder Air Removal

After the standard lift cylinder has been disassembled and then assembled again, it may be necessary to remove the air (bleed) from the cylinder.

1. With no load, lift and lower the mast and carriage through one complete cycle.

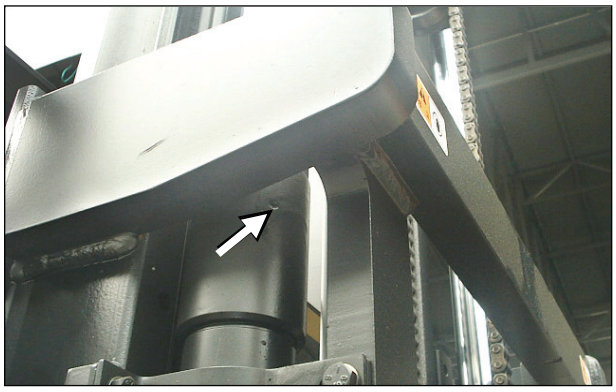
2. With the forks on the floor, check the oil level in the hydraulic tank. Add oil (if necessary) to bring the oil level to the full mark.

3. With no load, lift and lower the mast and carriage again through four complete cycles.

⚠ WARNING

The oil will have high pressure present. To prevent personal injury, do not remove the bleed screws completely. Keep hands and feet away from any parts of the truck that move, because the forks will lower when the bleed screw is loosened.

4. Lift the forks high enough to put a load on all stages of the lift cylinders.



Setscrew Locations
(Standard Cylinders)

NOTE: The Standard Lift mast has two secondary cylinders and no primary cylinders. The Full Free Triple Lift mast has one primary and two secondary cylinders.

5. Locate the setscrew on each lift cylinder. Slowly open setscrews no more than one turn. The weight of the carriage will force air and hydraulic oil out of the cylinders through the setscrews. Close the setscrews before all the pressure is out of the cylinders. This will prevent air from entering through the setscrews.

6. Repeat Steps 4 and 5 until there are no air bubbles at the setscrews.

7. After all the air is removed, tighten the setscrews to a torque of 5 to 7 N·m (45 to 60 lb·in).

8. Fill the hydraulic tank to the full mark.

9. Lift and lower the mast and carriage again through one complete cycle. If the mast does not operate smoothly, repeat Steps 3 through 9.

Mast and Carriage

Mast Adjustment - STD, FFL & FFT

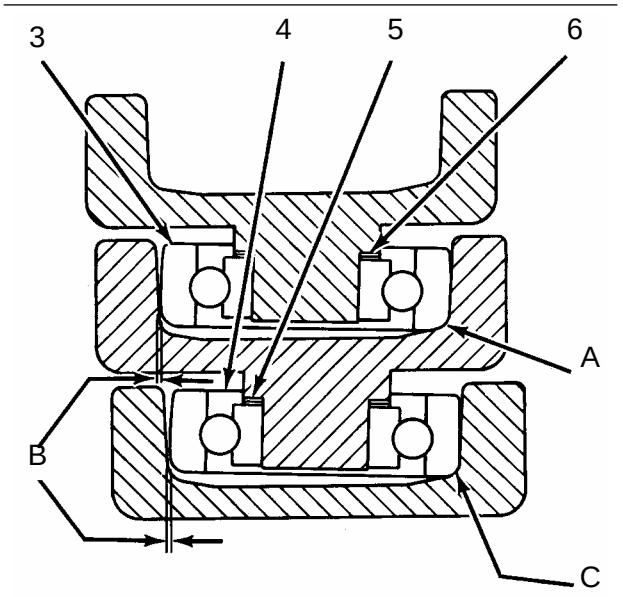
NOTE: The Standard, Full Free Lift and Full Free Triple Lift mast load bearings are all adjusted the same way. The mast shown in the following illustrations is the Full Free Triple Lift mast.

To make the mast clearance adjustments, mast must be removed from the lift truck.

Carriage, chain and lift cylinder must be removed from the mast for easy adjustments.

Use the procedure that follows to adjust the load bearings.

A. Lower Bearing Adjustment of Intermediate Mast



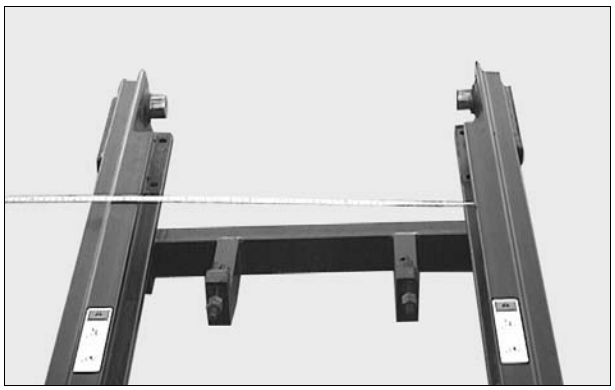
IDCS123S

Mast Adjustment Lower Bearings
(A) Zero clearance. (B) Minimum clearance. (C) Zero clearance.
(3) Bearing. (4) Bearing. (5) Shims. (6) Shims.

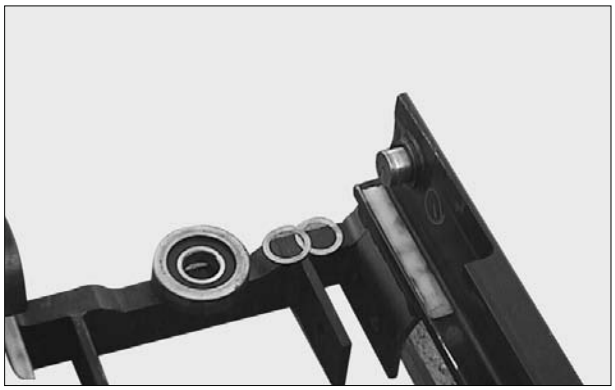
1. Select lower bearings (3) and (4) from the chart to obtain minimum clearance (B) between bearing and channel leg for full channel length. Use same bearing on left and right side.

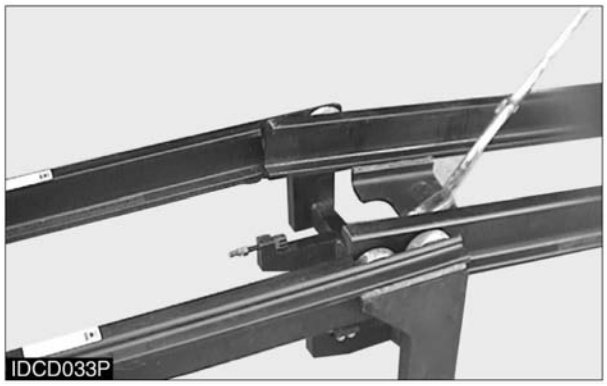
Mast And Carriage Bearings		
Part No.	Bearing Size	Bearing O.D.*
D581814	Under Size	108.6 mm(4.276 in)
D581815	Standard	109.6 mm(4.135 in)
D581816	Over Size	110.7 mm(4.358 in)

* Permissible tolerance ±0.08mm (.003in)



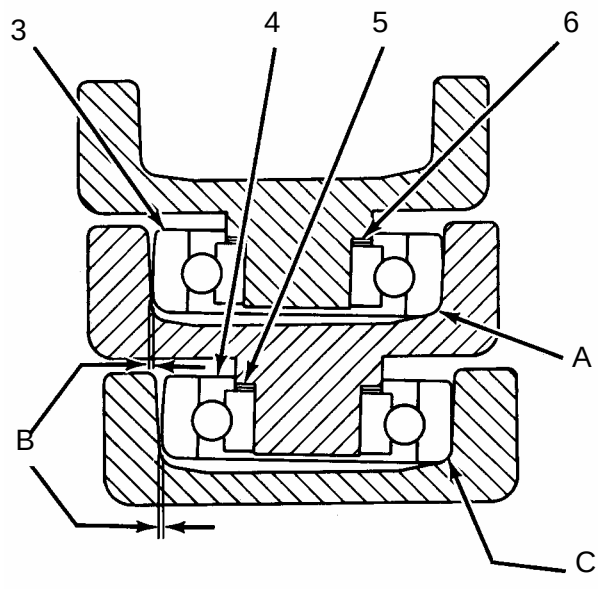
2. Find narrowest point by ruler on the stationary mast in the area where the bearings make contact at 475 mm (18.7 in) channel lap.





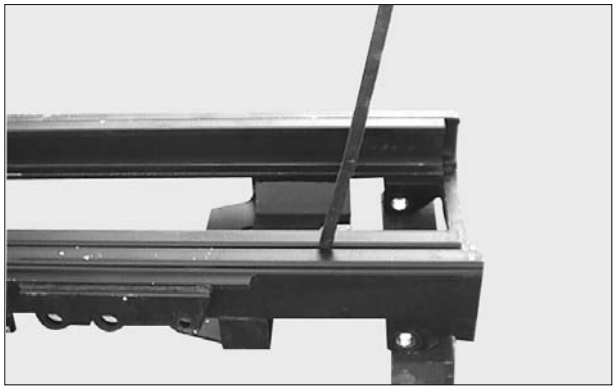
3. Install 1 mm shim to each bearing of intermediate lower and stationary upper basically. Lifting by crane, insert intermediate mast into stationary mast from the upper side.

NOTE: When installing shims (5) behind bearing (4), make sure the amount of shim is divided equally when positioned behind each bearing (4).

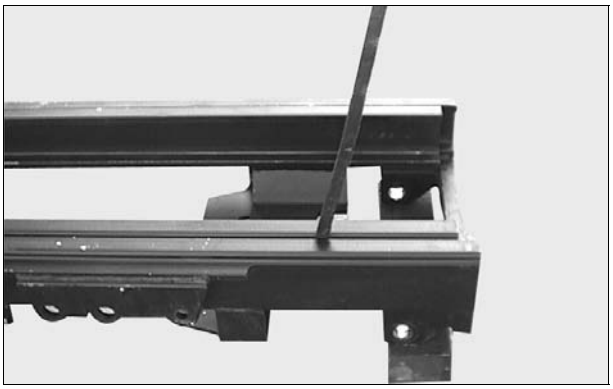


IDCS123S

Mast Adjustment Lower Bearings
(A, B, C) Zero clearance. (D) Minimum clearance.
(3, 4, 5) Bearing. (6, 7, 8) Shims.

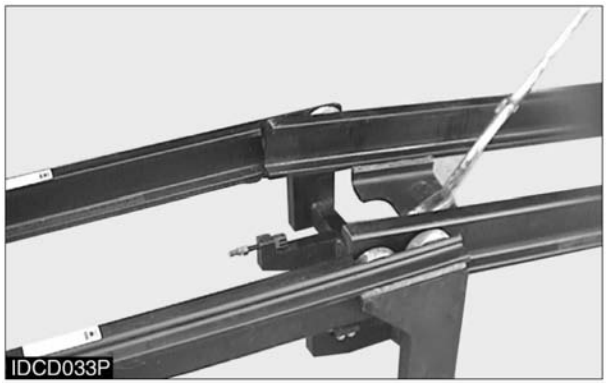


4. Make surer outer intermediate mast lower bearings are properly shimmed in the stationary mast by rolling up and down and moving outer intermediate mast to right and left. If clearance between both masts can be detected, pull out the intermediate mast from the stationary mast with crane and add shim 0.5 mm or 1 mm to both intermediate lower bearings.

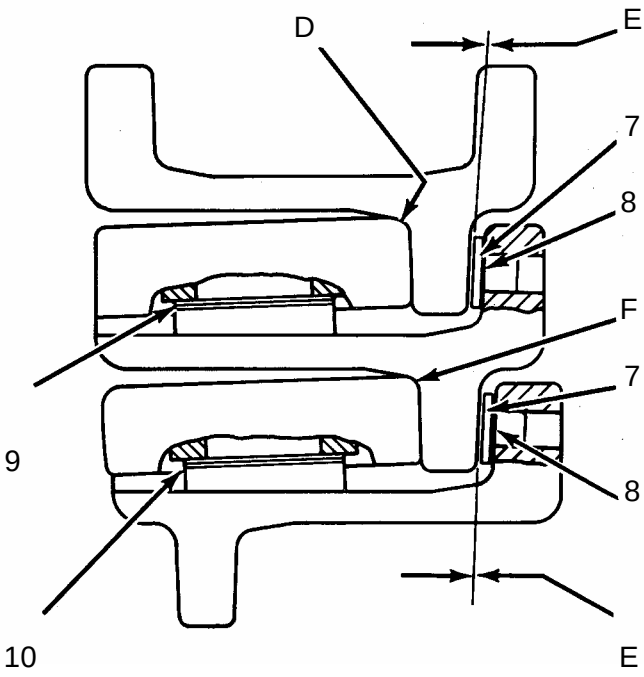


5. In case of standard and full free mast, inner lower bearings can be easily extruded by pulling down the inner mast from the bottom of stationary mast. If intermediate mast is stuck and cannot move by rolling up and down, there might be excessive shims. Pull out the intermediate mast from the stationary mast and remove shim 0.5 mm to both intermediate lower bearings. Repeat same procedure of above until properly shimmed. There is to be contact zero clearance (C) between intermediate lower bearings and stationary channel at approximately 475 mm (18.7 in) channel lap.

B. Upper Bearing Adjustment of Stationary Mast

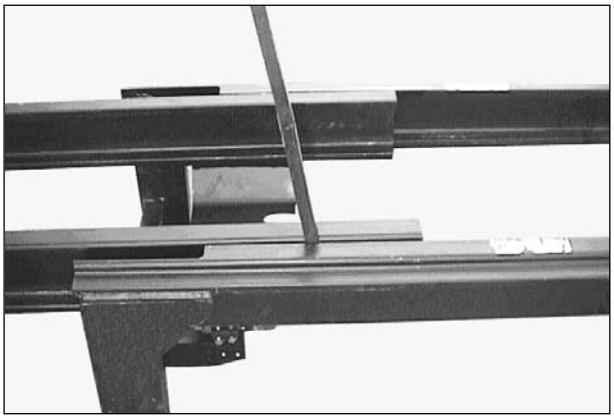


1. Lift by crane, and pull out intermediate mast from stationary mast. Install 1 mm shim to each bearing of stationary mast upper. Bearing should be part number D581814 under size bearing.

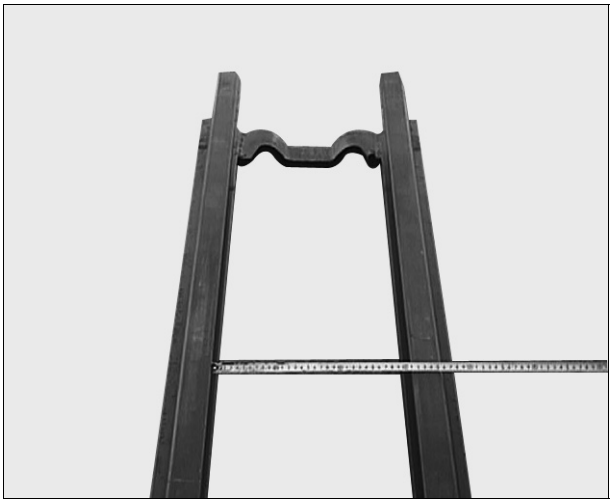


IDCS124S

Mast Adjustment Upper Bearings
(D) Zero clearance. (E) 0.80 mm (.031 in) Clearance maximum.
(F) Zero clearance. (7) Pads. (8) Shims. (9) Shims. (10) Shims.

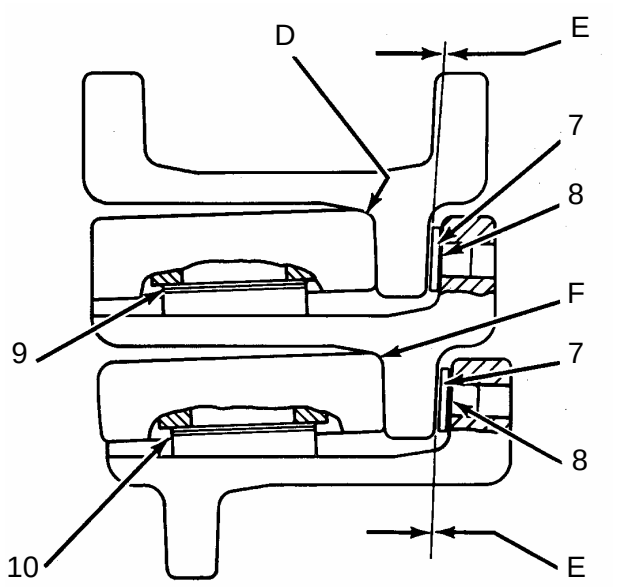


2. Make sure stationary mast upper bearings are properly shimmed by rolling up and down and moving intermediate mast to right and left. If clearance between both masts can be detected, pull out the intermediate mast from the stationary mast with crane and add shim 0.5 mm or 1 mm to both stationary upper bearings.



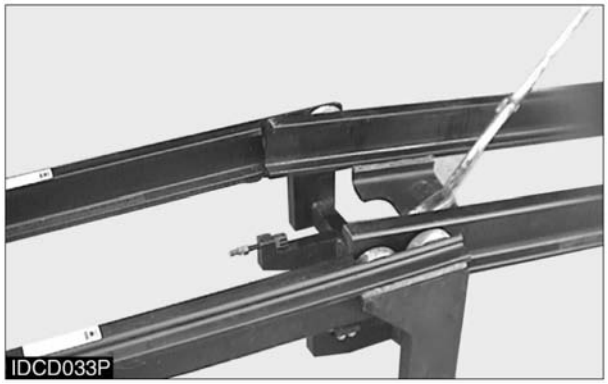
3. In case of standard and full free mast, stationary upper bearings can be easily extruded by pulling down the inner mast from the bottom of stationary mast. If intermediate mast is stuck and cannot move by rolling up and down, there might be excessive shims. Pull out the intermediate mast from the stationary mast and remove shim 0.5 mm to both stationary upper bearings. Repeat same procedure of above until properly shimmed. There is to be contact zero clearance (C) between stationary upper bearings and the widest point of intermediate mast to be checked before.

C. Upper Pad Adjustment



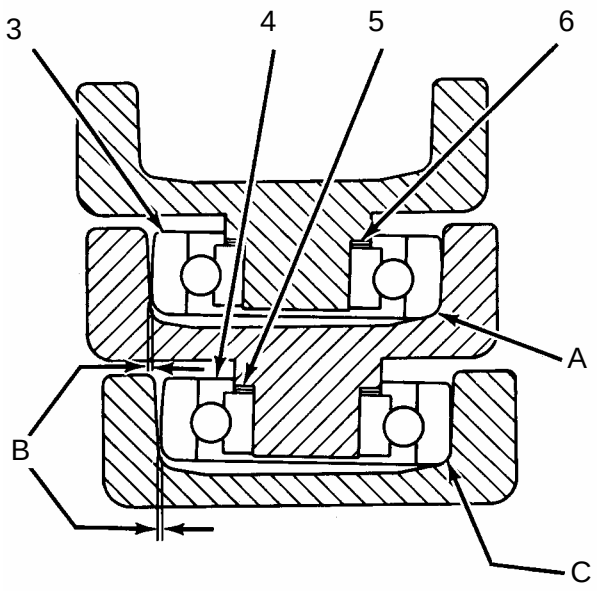
IDCS124S

Mast Adjustment Upper Bearings
(D) Zero clearance. (E) 0.80 mm (.031 in) Clearance maximum. (F) Zero clearance. (7) Pads. (8) Shims. (9) Shims. (10) Shims.



1. Install shims (8) behind each pad (7) until there is 0.80 mm (.031 in) maximum clearance (E) between the pads and the inner and intermediate masts with the masts at full extension. Lift by crane, and pull out intermediate mast from stationary mast and insert the shims behind each pad. In case of standard and full free mast, the pads of stationary upper can be easily extruded by pulling down the inner mast from the bottom of stationary mast.

D. Lower Bearing Adjustment of Inner Mast



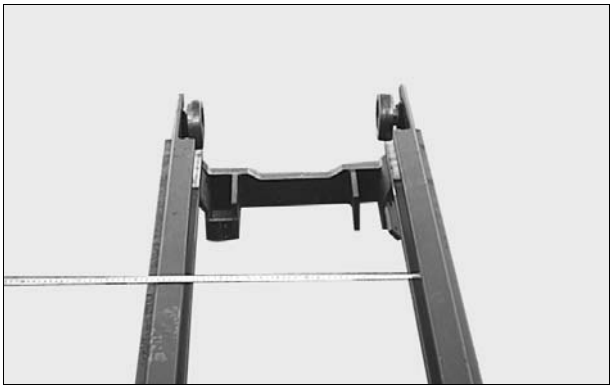
IDCS123S

Mast Adjustment Lower Bearings
(A) Zero Clearance. (B) Minimum Clearance. (C) Zero Clearance. (3) Bearing. (4) Bearing. (5) Shims. (6) Shims.

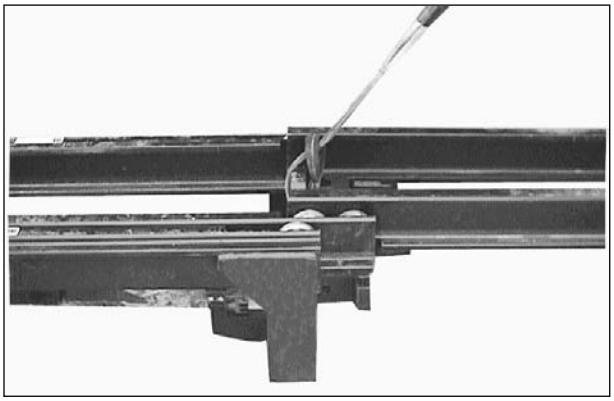
1. Select lower bearings (3) and (4) from the chart to obtain minimum clearance (B) between bearing and channel leg for full channel length. Use same bearing on left and right side.

Mast And Carriage Bearings		
Part No.	Bearing Size	Bearing O.D.*
D581814	Under Size	108.6 mm(4.276 in)
D581815	Standard	109.6 mm(4.135 in)
D581816	Over Size	110.7 mm(4.358 in)

* Permissible tolerance ± 0.08mm (.003in)



2. Find narrowest point by ruler on the intermediate mast in the area where the inner lower bearings make contact full length of intermediate mast excluding minimum channel lap 475 mm (18.7 in).



3. Install 1 mm shim to each bearing of inner lower and intermediate upper basically. Lift by crane, insert inner mast into intermediate mast from the upper side.

Mast Adjustment - Quad

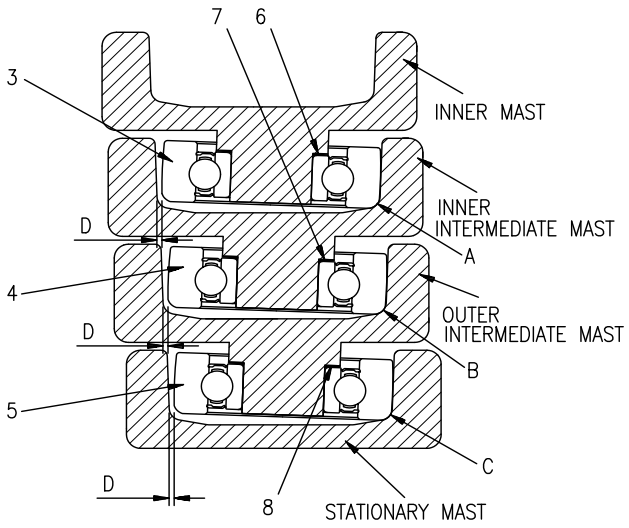
NOTE: The Standard, Full Free Lift, Full Free Triple Lift and Quad Lift mast load bearings are all adjusted the same way. The mast shown in the following illustrations is mainly the Full Free Triple Lift mast, but for necessary points illustrations of Quad Lift mast are inserted.

To make the mast clearance adjustments, mast must be removed from the lift truck.

Carriage, chain and lift cylinder must be removed from the mast for easy adjustments.

Use the procedure that follows to adjust the load bearings.

A. Lower Bearing Adjustment of Outer Intermediate Mast

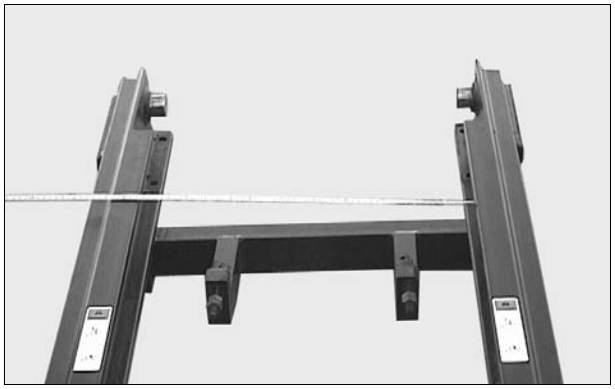


Mast Adjustment Lower Bearings
(A, B, C) Zero clearance. (D) Minimum clearance.
(3, 4, 5) Bearing. (6, 7, 8) Shims.

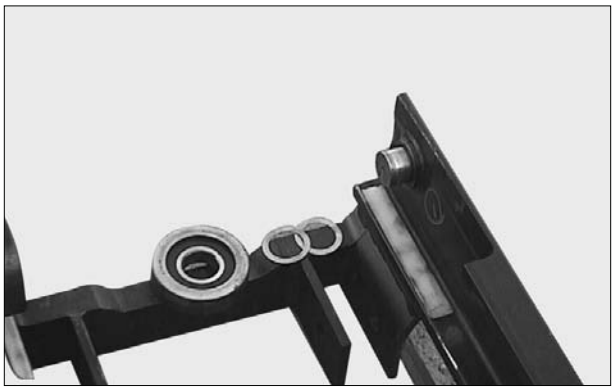
1. Select lower bearings (3), (4) and (5) from the chart to obtain minimum clearance (D) between bearing and channel leg for full channel length. Use same bearing on left and right side.

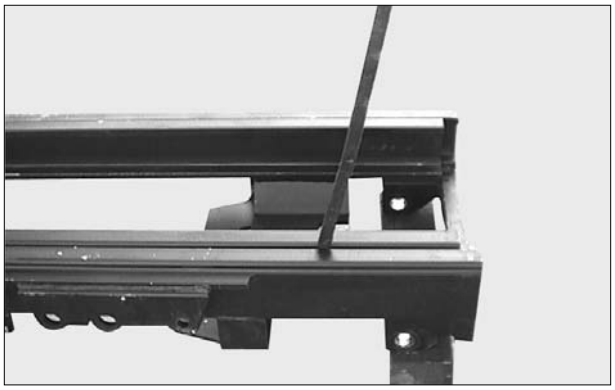
Mast And Carriage Bearings		
Part No.	Bearing Size	Bearing O.D.*
D581814	Under Size	108.6 mm(4.276 in)
D581815	Standard	109.6 mm(4.135 in)
D581816	Over Size	110.7 mm(4.358 in)

* Permissible tolerance ±0.08mm (.003in)



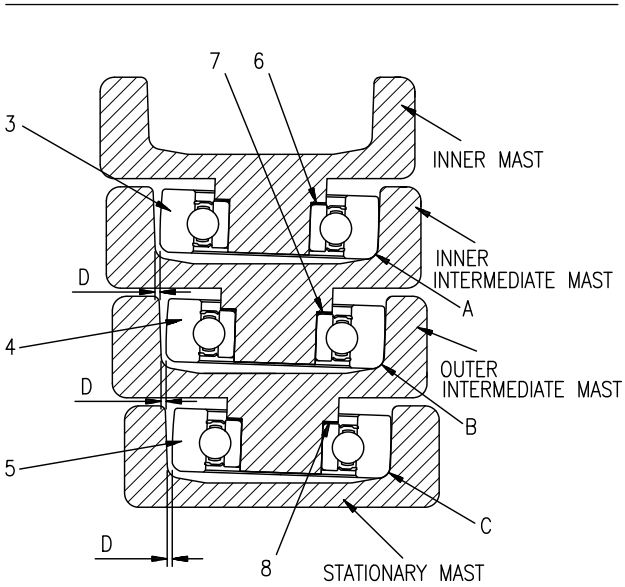
2. Find narrowest point by ruler on the stationary mast in the area where the bearings make contact at 475 mm (18.7 in) channel lap.



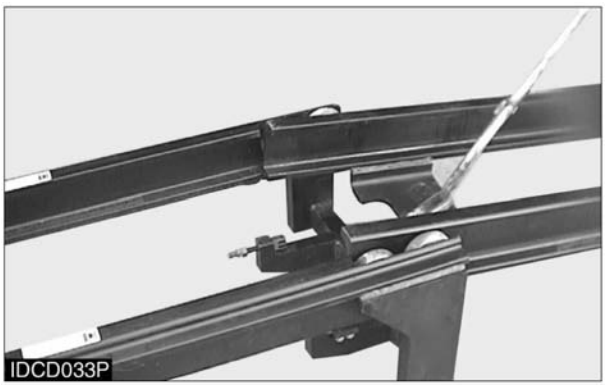


3. Install 1 mm shim to each bearing of intermediate lower and stationary upper basically. Lifting by crane, insert intermediate mast into stationary mast from the upper side.

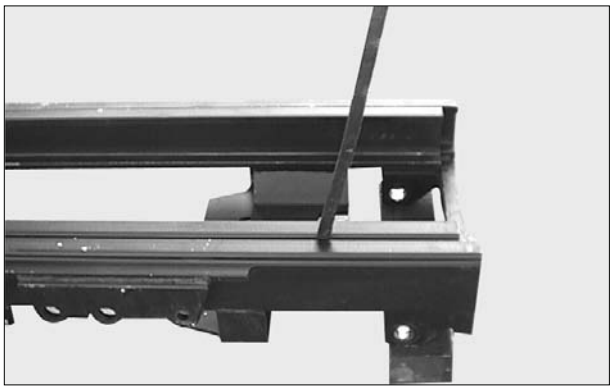
NOTE: When installing shims (5) behind bearing (4), make sure the amount of shim is divided equally when positioned behind each bearing (4).



Mast Adjustment Lower Bearings
(A, B, C) Zero clearance. (D) Minimum clearance.
(3, 4, 5) Bearing. (6, 7, 8) Shims.

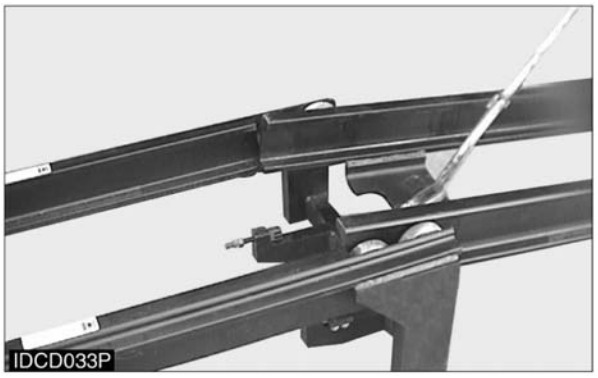


4. Make surer outer intermediate mast lower bearings are properly shimmed in the stationary mast by rolling up and down and moving outer intermediate mast to right and left. If clearance between both masts can be detected, pull out the intermediate mast from the stationary mast with crane and add shim 0.5 mm or 1 mm to both intermediate lower bearings.

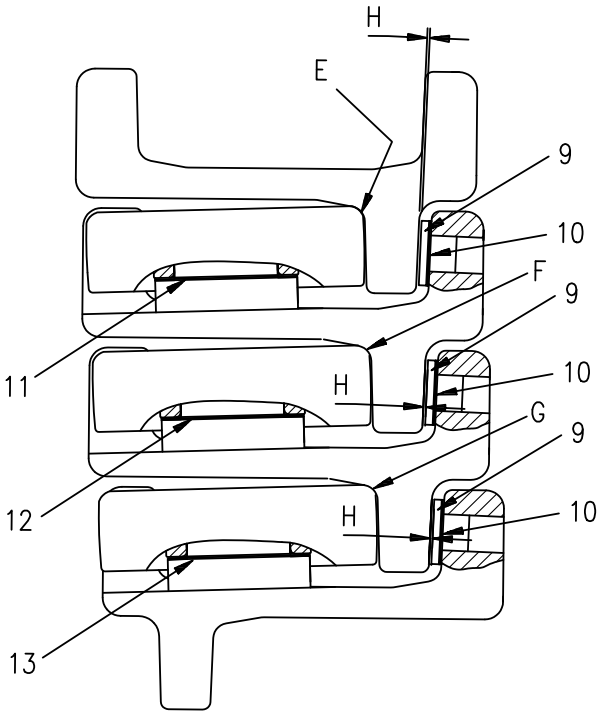


5. In case of standard and full free mast, inner lower bearings can be easily extruded by pulling down the inner mast from the bottom of stationary mast. If outer intermediate mast is stuck and cannot move by rolling up and down, there might be excessive shims. Pull out the outer intermediate mast from the stationary mast and remove shim 0.5 mm to both outer intermediate lower bearings. Repeat same procedure of above until properly shimmed. There is to be contact zero clearance (C) between intermediate lower bearings and stationary channel at approximately 475 mm (18.7 in) channel lap.

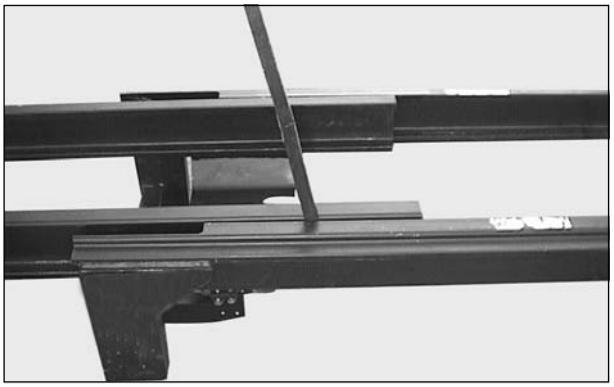
B. Upper Bearing Adjustment of Stationary Mast



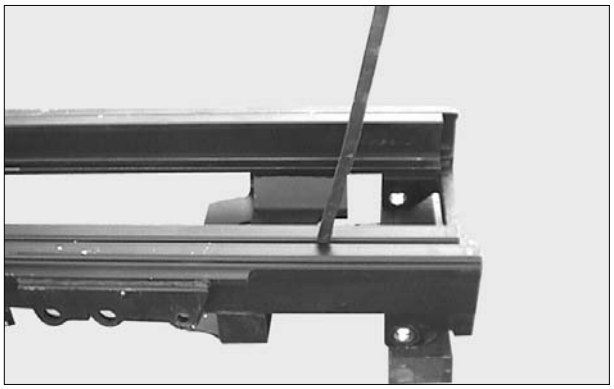
1. Lift by crane, and pull out intermediate mast from stationary mast. Install 1 mm shim to each bearing of stationary mast upper. Bearing should be part number D581814 under size bearing.



Mast Adjustment Upper Bearings
(E, F, G) Zero clearance.
(H) 0.80 mm (.031 in) Clearance maximum.
(9) Pads. (10) Shims. (11, 12, 13) Shims.

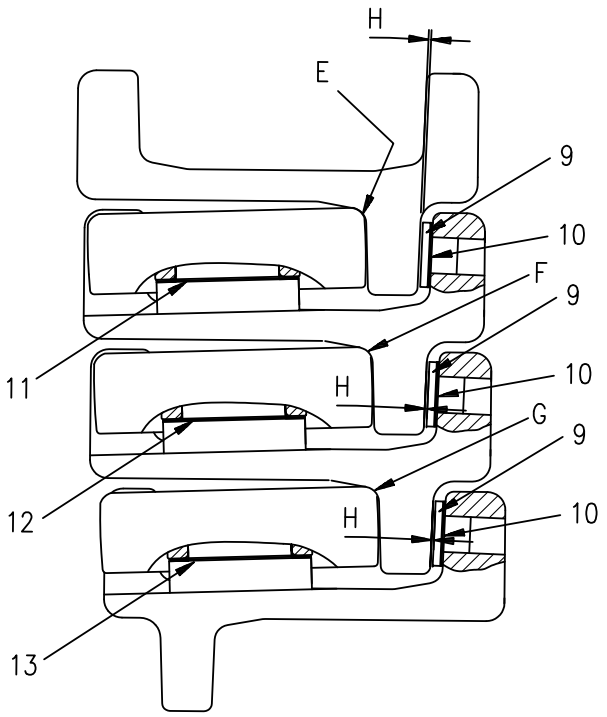


2. Make sure stationary mast upper bearings are properly shimmed by rolling up and down and moving intermediate mast to right and left. If clearance between both masts can be detected, pull out the intermediate mast from the stationary mast with crane and add shim 0.5 mm or 1 mm to both stationary upper bearings.

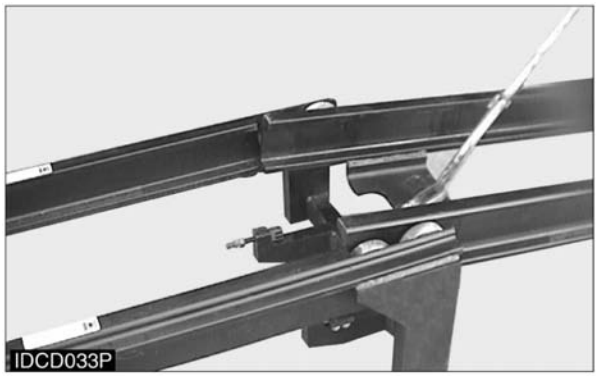


3. In case of standard and full free mast, stationary upper bearings can be easily extruded by pulling down the inner mast from the bottom of stationary mast. If outer intermediate mast is stuck and cannot move by rolling up and down, there might be excessive shims. Pull out the outer intermediate mast from the stationary mast and remove shim 0.5 mm to both stationary upper bearings. Repeat same procedure of above until properly shimmed. There is to be contact zero clearance (G) between stationary upper bearings and the widest point of intermediate mast to be checked before.

C. Upper Pad Adjustment



Mast Adjustment Upper Bearings
(E, F, G) Zero clearance.
(H) 0.80 mm (.031 in) Clearance maximum.
(9) Pads. (10) Shims. (11, 12, 13) Shims.

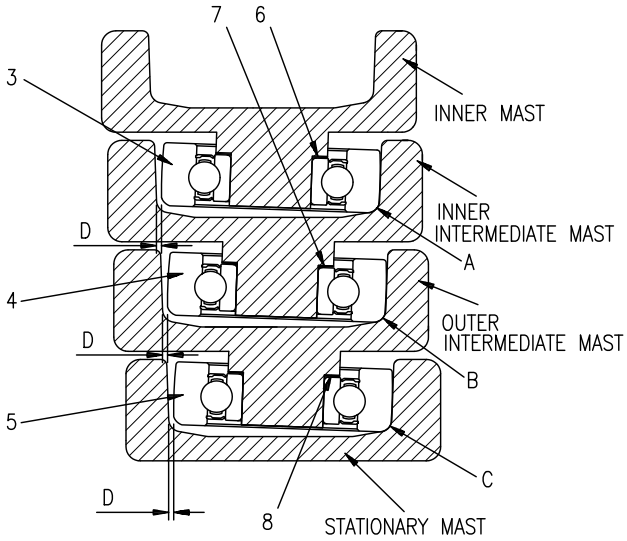


1. Install shims (10) behind each pad (9) until there is 0.80 mm (.031 in) maximum clearance (H) between the pads and the inner and intermediate masts with the masts at full extension. Lift by crane, and pull out intermediate mast from stationary mast and insert the shims behind each pad. In case of standard and full free mast, the pads of stationary upper can be easily extruded by pulling down the inner mast from the bottom of stationary mast.

D. Inner Intermediate Mast Adjustment

Follow the same procedure with above A~C.

E. Lower Bearing Adjustment of Inner Mast

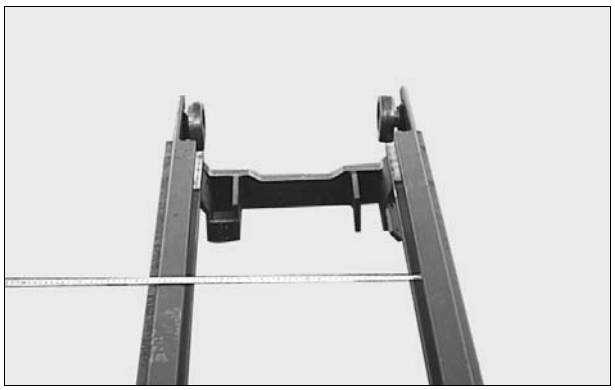


Mast Adjustment Lower Bearings
(A, B, C) Zero clearance. (D) Minimum clearance.
(3, 4, 5) Bearing. (6, 7, 8) Shims.

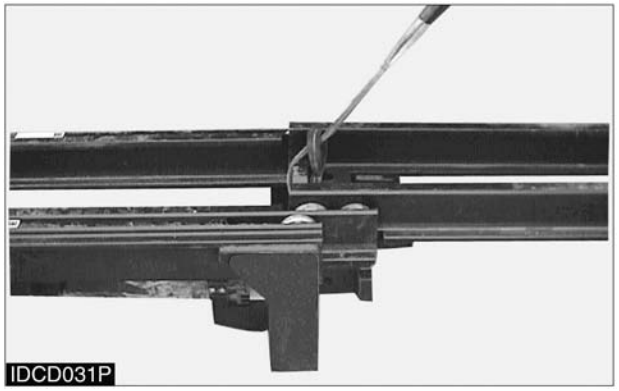
1. Select lower bearings (3), (4) and (5) from the chart to obtain minimum clearance (D) between bearing and channel leg for full channel length. Use same bearing on left and right side.

Mast And Carriage Bearings		
Part No.	Bearing Size	Bearing O.D.*
D581814	Under Size	108.6 mm(4.276 in)
D581815	Standard	109.6 mm(4.135 in)
D581816	Over Size	110.7 mm(4.358 in)

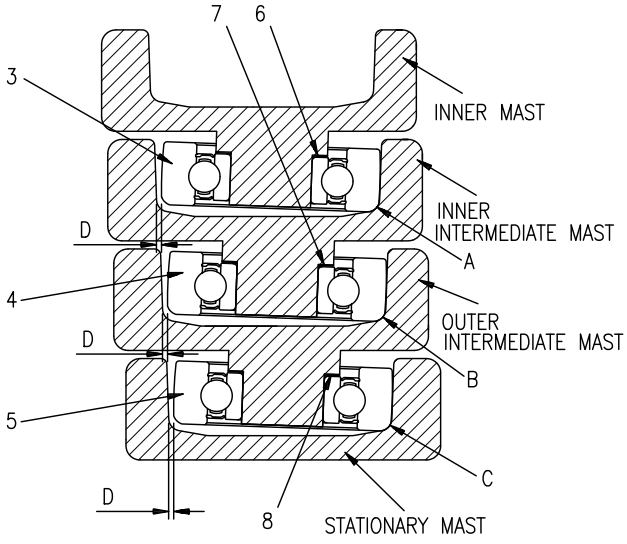
* Permissible tolerance ± 0.08mm (.003in)



2. Find narrowest point by ruler on the inner intermediate mast in the area where the inner lower bearings make contact full length of inner intermediate mast excluding minimum channel lap 475 mm (18.7 in).



3. Install 1 mm shim to each bearing of inner lower and inner intermediate upper basically. Lift by crane, insert inner mast into intermediate mast from the upper side.



Mast Adjustment Lower Bearings
(A, B, C) Zero clearance. (D) Minimum clearance.
(3, 4, 5) Bearing. (6, 7, 8) Shims.

4. Make sure inner mast lower bearings are properly shimmed in the intermediate mast by rolling up and down and moving inner mast to right and left. If clearance between both masts can be detected, pull down the inner mast from the bottom of intermediate mast. Inner lower bearings can be easily extruded. Add shim 0.5 mm or 1 mm to both inner lower bearings. If inner mast is stuck and cannot move by rolling up and down, there might be excessive shim. Pull out the inner mast from the inner intermediate mast and remove shim 0.5 mm to both inner lower bearings. Repeat same procedure of above until properly shimmed. There is to be contact zero clearance (C) between inner lower bearings and inner intermediate channel at narrowest point.

F. Upper Bearing Adjustment of Inner Intermediate Mast

Follow same procedure with above B.

G. Upper Pad Adjustment of Inner Intermediate Mast

Follow same procedure with above C.

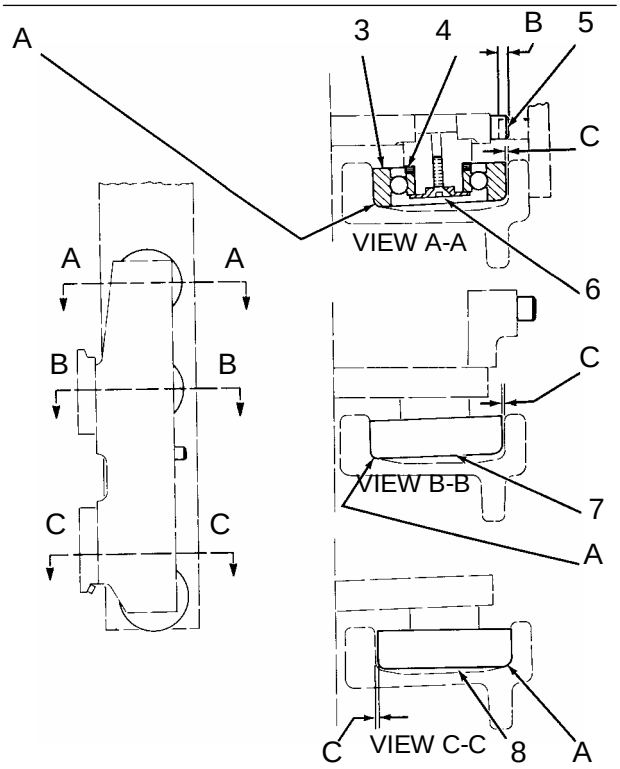
Carriage Adjustment

STD, FFL & FFT

NOTE: The standard, Full Free Lift and Full Free Triple Lift carriage load bearings are all adjusted the same way. The Full Free Triple Lift carriage is shown in the following illustrations.

To make the carriage clearance adjustments, carriage must be removed from the mast.

Use the procedure that follows to adjust carriage load bearings.



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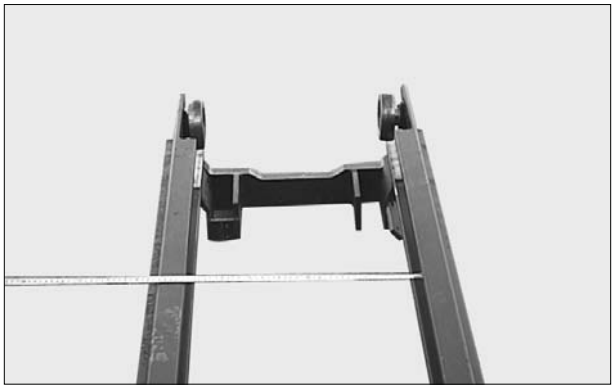
Carriage Adjustment
(3) Upper Bearings. (4) Shims. (5) Bolt. (6) Screw.
(7) Middle Bearings. (8) Lower Bearings. (A) Zero Clearance.
(B) 6.0 to 9.0 mm. (.236 to .354 in) Clearance.
(C) Minimum Clearance.

1. Select lower bearings from the chart to obtain minimum clearance (B) between bearings and channel leg for full channel length. Use same bearing in all six locations.

Mast And Carriage Bearings		
Part No.	Bearing Size	Bearing O.D.*
D581814	Under Size	108.6 mm(4.276 in)
D581815	Standard	109.6 mm(4.135 in)
D581816	Over Size	110.7 mm(4.358 in)

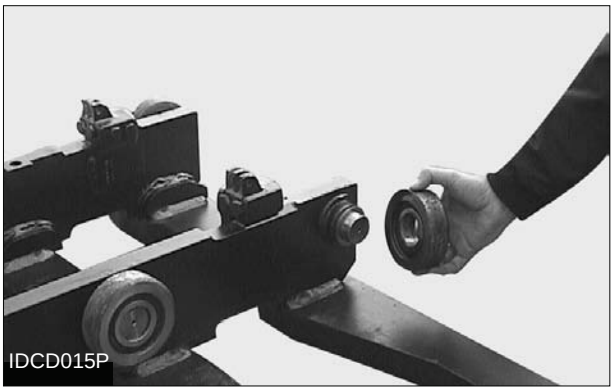
* Permissible tolerance ±0.08mm (.003in)

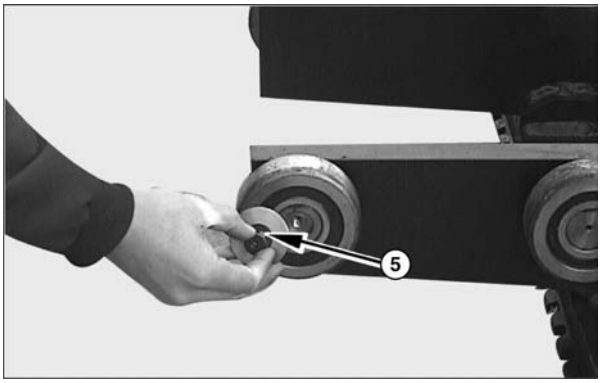


2. Find narrowest point by ruler on the inner mast in the area where the bearings make contact.

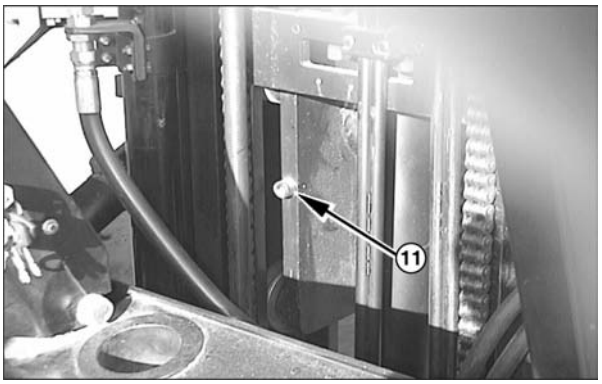
3. Install enough shims (4) that have been divided into two equal groups behind bearings (3). At installation, there is to be contact [zero clearance (A)] between the bearings and the narrowest point of inner mast.

4. Do step 2 through 3 for other sets of bearings.





5. Tighten screw (5) that holds the top bearings to the carriage to a torque of 34±7 N·m (25±5 lb· ft)

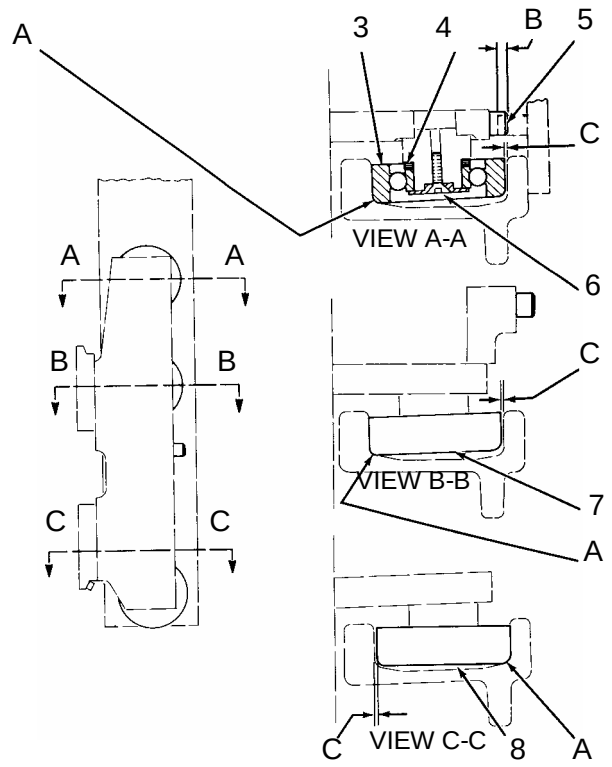


6. Shim stop bolt (11) as required to obtain a 6 to 9 mm (.24 to .35 in) lap with top carriage stop on the inner upright.

Quad Mast

To make the carriage clearance adjustments, carriage must be removed from the mast.

Use the procedure that follows to adjust carriage load bearings.



IDCS125S

Carriage Adjustment
(3) Upper Bearings. (4) Shims. (5) Bolt. (6) Screw.
(7) Middle Bearings. (8) Lower Bearings. (A) Zero Clearance.
(B) 6.0 to 9.0 mm. (.236 to .354 in) Clearance.
(C) Minimum Clearance.

1. Select lower bearings from the chart to obtain minimum clearance (B) between bearings and channel leg for full channel length. Use same bearing in all six locations.

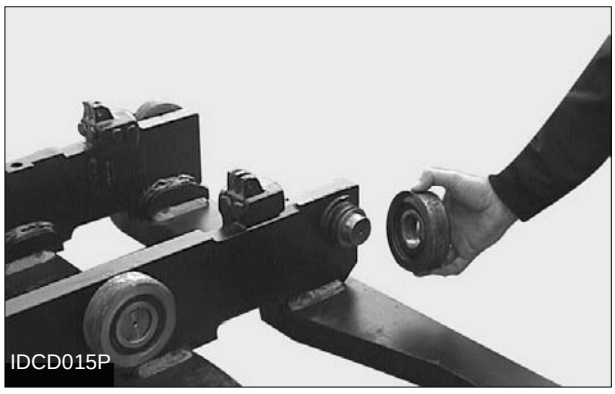
Mast And Carriage Bearings		
Part No.	Bearing Size	Bearing O.D.*
D581814	Under Size	108.6 mm(4.276 in)
D581815	Standard	109.6 mm(4.135 in)
D581816	Over Size	110.7 mm(4.358 in)

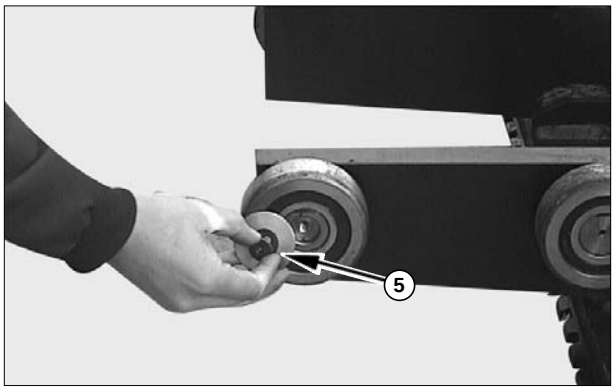
* Permissible tolerance ±0.08mm (.003in)

2. Find narrowest point by ruler on the inner mast in the area where the bearings make contact.

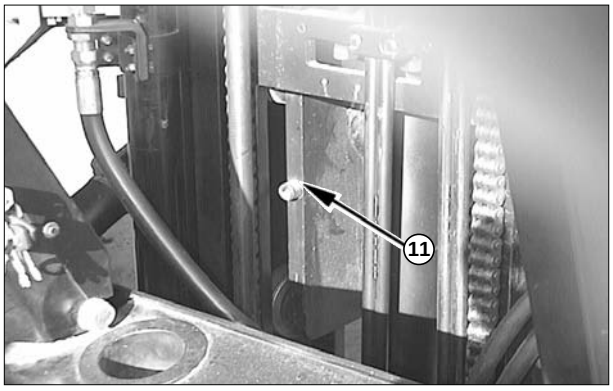
3. Install enough shims (4) that have been divided into two equal groups behind bearings (3). At installation, there is to be contact [zero clearance (A)] between the bearings and the narrowest point of inner mast.

4. Do step 2 through 3 for other sets of bearings.





5. Tighten screw (5) that holds the top bearings to the carriage to a torque of 34±7 N·m (25±5 lb· ft)



6. Shim stop bolt (11) as required to obtain a 6 to 9 mm (.24 to .35 in) lap with top carriage stop on the inner upright.

Chain Adjustment

Chain Adjustment Check

Chain Adjustment Check

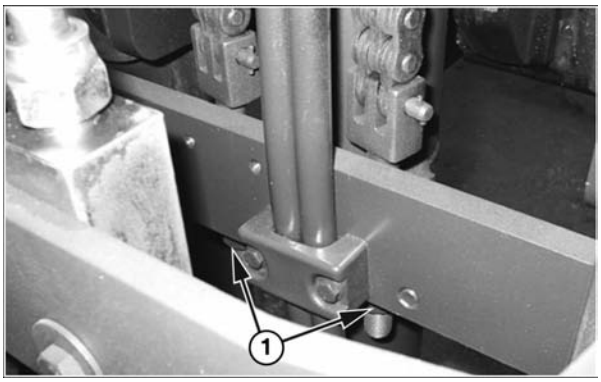
Lift the carriage and mast high enough to put their full weight on the carriage and mast chains. Check the chains, and make sure the tension is the same.

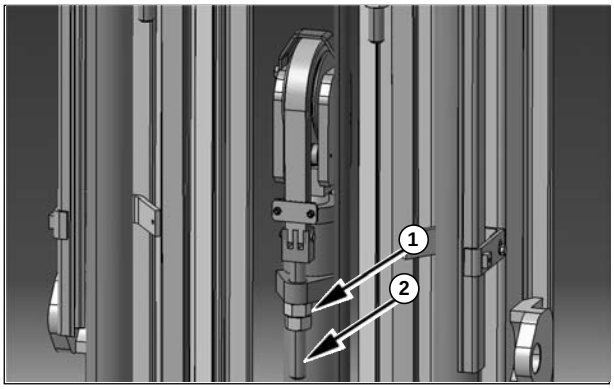
Chain Adjustment

If the tension is not the same on both chains, do the procedure that follows:

⚠ WARNING

Personal injury can be caused by sudden movement of the mast and carriage. Blocks must be used to prevent the mast and carriage from any movement while the adjustments are made. Keep hands and feet clear of any parts that can move.



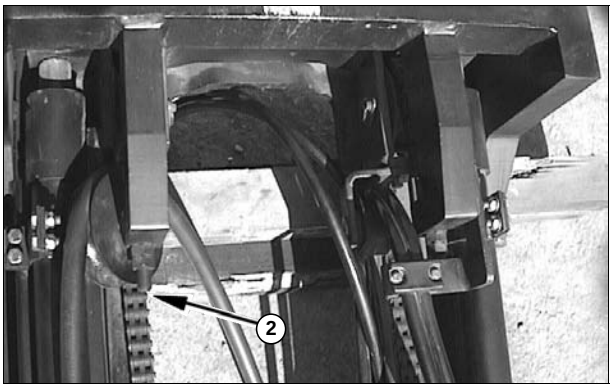


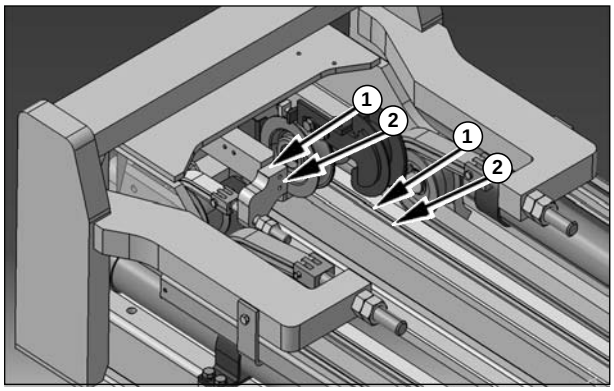
Inner Lift Chains
(1) Chain Anchor Nuts. (2) Chain Anchor Bolt

1. Lift the mast and carriage and put blocks under the mast and carriage to release the tension from the lift chains.

2. Make adjustments to chain anchor nuts (1) or bolts (2) for equal tension of the mast and carriage chains.

3. Put LOCTITE NO.242 Thread Lock on the threads of the locknuts after the adjustment is completed.





Outer Lift Chains
(1) Chain Anchor Nuts.
(2) Chain Anchor Bolts.

Chain Wear Test

Chain wear test is a measurement of wear of the chain links and pins. Do the steps that follow to check chain wear.

1. Lift the mast and carriage enough to put tension on the lift chains.

2. Measure precisely ten links of chain distance at the center of pins in millimeter.
A chain wear gauge can also be used.

3. Calculate chain wear rate.

*** For STD, FF, FFT Mast**

New one pitch = 19.05 mm (D20/25/30/32S Model)
25.40 mm (D33S, G33P Model)

Chain wear rate (%)

$$= \frac{\text{Actual measurement - 190.5}}{190.5} \times 100 \text{ (D20/32S Model)}$$

$$= \frac{\text{Actual measurement - 254}}{254} \times 100 \text{ (D33S,G33P Model)}$$

*** For Quad Mast**

- Carriage & Outer Mast Chain

Chain wear rate (%)

$$= \frac{\text{Actual measurement - 254}}{254} \times 100$$

- Inner Mast Chain

Chain wear rate (%)

$$= \frac{\text{Actual measurement - 190.5}}{190.5} \times 100$$

⚠ WARNING

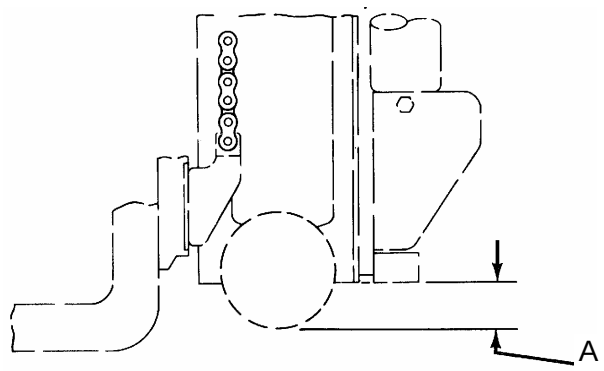
Do not put a lift truck into service if the chain wear indication is 2% or more. A reading of 2% or more could cause damage or injury to persons.

4. If the chain wear indication is 2% or more, replace the lift chain.

Carriage and Mast Height Adjustment

1. Move the mast either forward or backward so it is in the vertical position.

2. Lower the carriage completely.



IDCS191S

3. On Full Free Lift Full Free Triple Lift and Quad Lift models, the bottom of the inner mast must be even with the bottom of the stationary mast.

4. Measure the distance from the bottom of the inner upright to the bottom of carriage bearing.

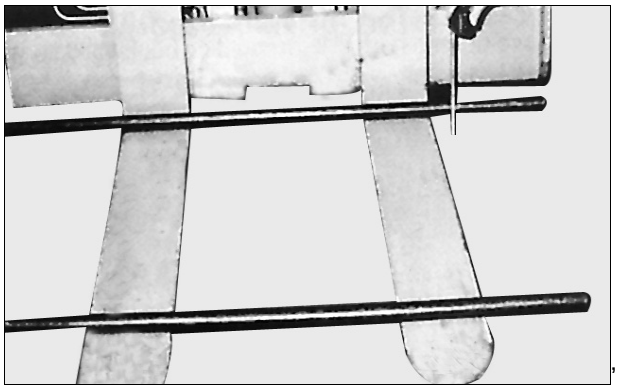
5. The measurement (A) must be as follows:
STD.....Zero
FFL, FFTL & Quad... 41±1.5 mm (1.61± .06 in)

NOTE: On Standard Lift models the bearing must be even (flush) with the inner mast. If the above measurements are not correct, make adjustments to the chains to get the correct measurement. See Chain Adjustments in TESTING AND ADJUSTING.

Forks Parallel Check

1. Lift the mast and operate the tilt control lever, until the top surface of the forks is parallel with the floor. Place two straight bars, that are the same width as the carriage, across the forks as shown. Measure the distance from the bottom of each end of the two bars to the floor. The forks must be parallel within 3 mm (.12 in) for Full Tapered and Polished (FTP) forks, all other forks 6.4 mm (.25 in), for their complete length.

2. If not parallel, determine which one is defective and replace it.



Forks Parallel Check
(Typical Example)

Tilt Cylinder Alignment

If the tilt cylinders are out of alignment, extra stresses in the mast assembly and the mast hinge area will result. To prevent damage, the tilt cylinders must stop evenly at the end of the tilt back and tilt forward strokes.

Tilt Angle Check

Tilt Angle Check (Typical Example)

The tilt angle of the mast must be checked in the full tilt back and full tilt forward positions. A tilt indicator or a protractor can be used to measure the angle. Both sides of the mast must be checked to make sure that the mast is not twisted.

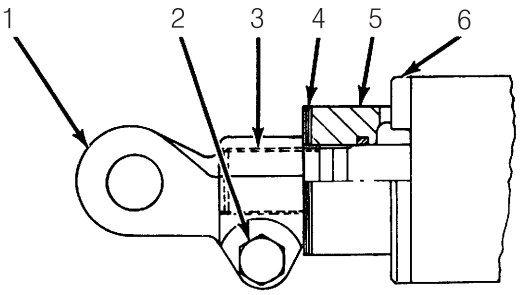
The tilt angle is determined by the tilt cylinders used. See tilt cylinders in specifications to determine the tilt angle from the cylinder being used.

Tilt Cylinder Length Check

Tilt Cylinder Length Check

1. Tilt the mast to full forward position. Measure the extended length of the cylinder rods from the cylinder housing to the mast. The difference of length between the two cylinder rods must be within 3.18 mm (.125 in) of each other.

Tilt Cylinders With Tilt Back Limiting Group



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Tilt Cylinder Adjustment
(1) Pivot eye. (2) Bolt. (3) Rod. (4) Shims. (5) Spacer.
(6) Head.

1. With the mast at full forward tilt, loosen bolt (2).

2. Slide spacer (5) back so rod (3) can be turned into or out of pivot eye (1) to obtain the correct length or angle.

⚠ WARNING

Tilt cylinder pivot eyes can loosen if the torque on the pivot eye clamping bolt is not tight enough. This will let the tilt cylinder rod turn in the tilt cylinder eye. The cylinder rod may then twist our of the pivot eye and the tilt cylinder will be out of alignment or may let the mast fall and cause personal injury or damage. When the rod lengths are made even, the tilt angle differences or the mast alignment will no longer be a problem.

3. Tighten bolt (2) and the nut to a torque of 95 ± 15 N·m (70 ± 10 lb·ft). If the nuts had been removed completely, it needs to be replaced with the new ones.

4. With mast at full back tilt, install shims (4) as required to permit no gap between spacer (5) and head (6). Shim so mast does not twist at full tilt back.

Drift Test

Drift is movement of the mast or carriage that is the result of hydraulic leakage in the cylinders or control valve. Before testing the drift:

⚠ WARNING

Personal injury can be caused by sudden movement of the mast or carriage. Use wood blocks and clamps to hold the mast in this position. Keep hands and feet clear of any parts that can move.

---

1. Check the chain adjustment and tilt cylinder alignment and make necessary adjustments.

2. Lift the mast approximately 762 mm (30 in). Use wood blocks and clamps to hold the mast in this position.

3. Check the mast hinge bolts to make sure they are tight.

4. Remove the blocks and clamps and lower the mast.

Drift Test For Lift System

1. Secure a rated capacity load on the forks of the lift truck. Operate the lift truck through a complete lift and tilt cycle until the oil is at normal temperature of operation, 45 to 55 °C (113 to 131 °F).

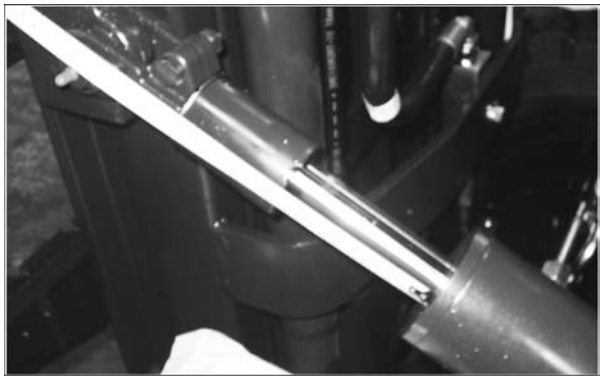
2. Put the mast in a vertical position.
Raise a rated capacity load to a sufficient height to test the lift cylinders.

3. Measure any drift of the carriage for a ten minute period. Drift for all models shall not exceed 100.0 mm (4.00 in).

Drift Test For The Tilt System

1. Put a rated capacity load on the forks on the lift truck. Operate the lift truck through a complete lift and tilt cycle until the oil is at normal temperature for operation, 45 to 55 °C (113 to 131 °F).

2. Put the mast in a vertical position. Raise a rated capacity load to a height of 2.5 meters (8.2 ft). In the case of trucks with less than 2.5 meters (8.2 ft) height extension, raise the load to the truck's maximum height.

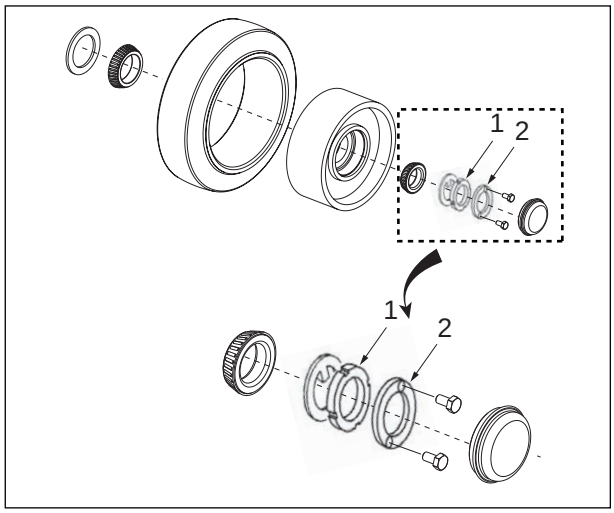


Tilt Drift Check.

3. The tilt drift is measured as the charge in the tilt cylinder stroke. Measure any drift of the mast for ten minute period.
Drift for shall not exceed 35.5 mm (1.40 in).

Steering System

Steer Wheel Bearing Adjustment



Bearing Adjustment
(1)Nut (2) Lock Washer

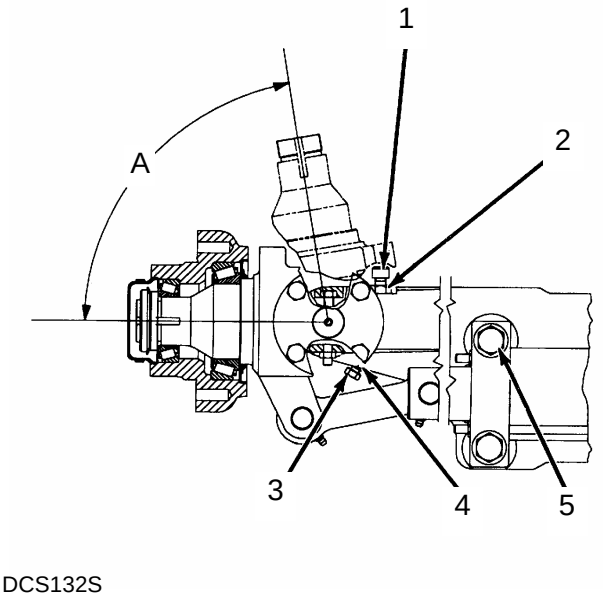
1. Tighten nut (1) slowly to 135 N·m (100 lb·ft) while the wheels is rotated in both directions to put the bearings into position.

2. Loosen nut (1) completely. Tighten nut (1) again to..... 50 ± 5 N·m (37 ± 4 lb·ft) .

3. Put the lock washer (2) on the nut and align the hole. In case of no match, rotate the nut (1) about 1/32 turn clockwise.

4. Apply loctite 242 on the threads of bots and tighten them at 8±3 N·m (6±2 lb·ft).

Steering Axle Stop Adjustment



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Steer Angle
(1) Bolt. (2) Nut. (3) Bolt. (4) Nut. (5) Bolts. (A) 80° angle.

Use the procedure that follows to make an adjustment to the steer axle turning angle.

1. Adjust the cylinder rod extension so it is equal on both sides of the axle.

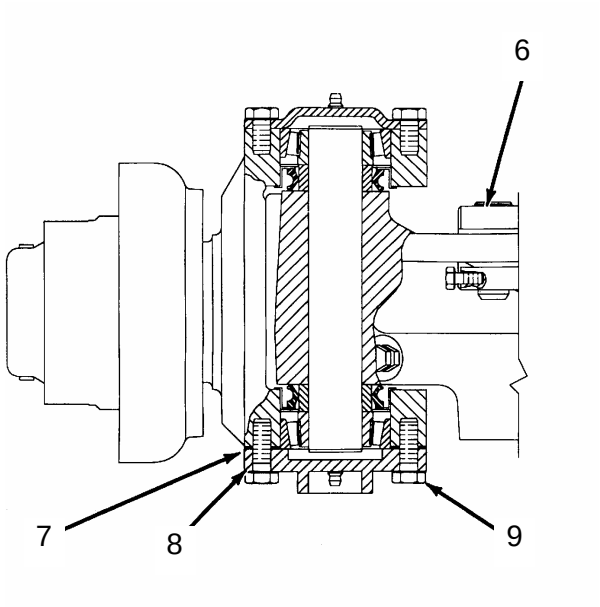
2. Loosen nuts (2) and (4) on both sides of the steer axle.

3. Turn the steer wheel one direction until the steer cylinder rod extension measures 94mm(3.7 in) more than the straight ahead measurement.

4. Adjust stop bolt (1) on one side and stop bolt (3) on the other.

5. Tighten nut (2) on one side and nut (4) on the other side. Turn the steer wheel the opposite direction and do the same procedure for the opposite stop bolts. This will give a maximum cramp angle of 80°

Steering Knuckle Bearing Preload Adjustment



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Steering Knuckle Bearing Preload Adjustment
(6) Steering link. (7) Shims. (8) Cover. (9) Bolts.

1. During assembly of the steering knuckle, install the upper bearing cup, cone and seal.

2. Install lower bearing group cover (8) without shims. Tighten two opposed cover bolts (9) to a torque of 5.6 N·m (50 lb·in).

3. Measure the clearance between cover (8) and the axle beam at each bolt with a feeler gauge.

4. Take an average of the measurements found in Step 3. Select shims (7) equal in thickness to the average clearance.

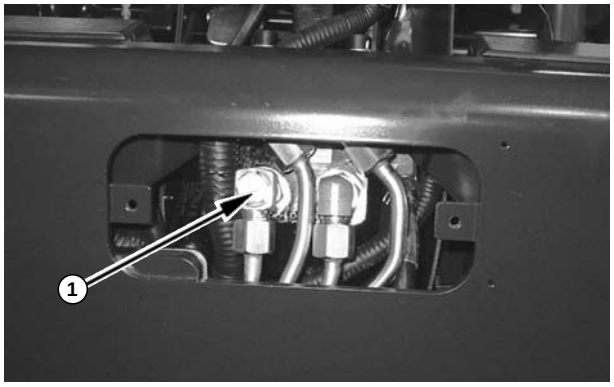
5. Remove the bearing group and install shims (7), cover (8) and bolts (9). Tighten bolts (9) to a torque of 55±6 N·m (40±5 lb·ft).

6. With steering links (6) disconnected from the steering cylinder, check knuckle for 4.5 to 6.8 N·m(40 to 60 lb·in) of rolling torque. Add or remove shims from cover (8) to obtain the proper rolling torque.

7. Connect links (6) to the steering cylinder. Tighten cylinder mounting bolts (5) to a torque of 460 ± 60 N·m (340 ± 40 lb·ft).

Steering System Pressure Check

If the steering system does not work correctly, check the hydraulic tank for the correct oil level and the hoses and connections for leakage. If all these items are correct, use the Pressure Gauge Kit to check the steering hydraulic system and its relief pressure setting.



Hydraulic Steering Gear
(1) Elbow (Pressure line from priority valve).

⚠ WARNING

Hydraulic pressure can cause personal injury. Before any steering system hydraulic lines or components are disconnected, make sure all hydraulic pressure is released in the steering system. Move the steer wheels to the left and right and then to the straight forward direction.

Check steering system relief pressure as follows:

1. Turn the engine off.

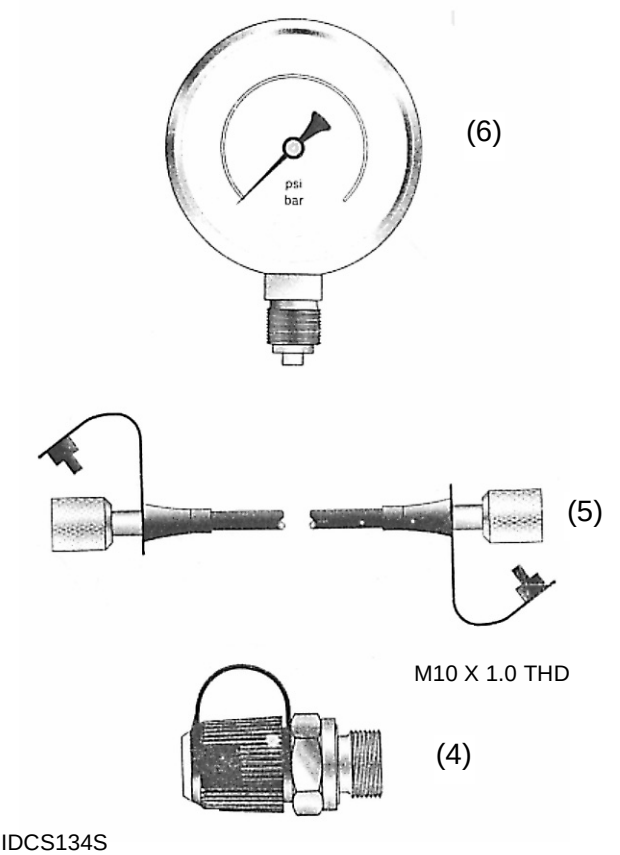
2. Remove plug from elbow(1)
Install pressure-checking adapter(4) and connect pressure-tube (5) and pressure gage (6). Pressure gage(6) has a range of 28,000 kpa (4,000psi).

3. Move the seat to the normal position for operation, turn the key switch to the ON position and activate the hydraulic controls until the oil is at a temper-ature for normal operation.

4. Turn the steer wheels to the left or right against the stops and make a note of the indication on the pressure gauge.

5. The indication on the pressure gauge must be the priority valve relief setting of 9000 + 300 kPa (1305+43.5 psi). If the indication is correct and a problem exists, then there is possibly a mechanical failure in the steering system.

6. If the indication is not correct, then there is steering hydraulic failure in the components.



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(4) Pressure-Checking Adapter. (5) Pressure-Tube.
(6) Pressure Gauge.

7. If the steering gear and the priority valve are working properly, the steering cylinder is defective and must be repaired.

8. Correct the problem and check steering relief valve pressure again.

a. With the engine running, turn the steer wheels in any directions and read the indication on pressure gauge (6).

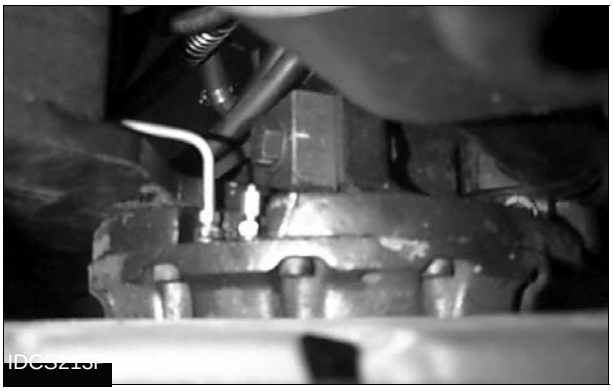
b. If the indication is approximately the pressure shown in Step 5, then the steering gear has a hydraulic failure.

c. If the indication is too low or too high, then the priority valve or its components must be replaced.

Brake System

Brake System Air Removal

When the brake pedal resistance is spongy (not solid) it is usually an indication that there is air in the brake hydraulic system. The cause may be low fluid or oil level, leakage in the system, a broken brake line or a brake line that is not connected. To remove air from the brake system, do the procedure that follows.



Right Bleed Screw Location (Left Not Shown)
(1) Bleed Screw.

1. Check the hydraulic oil level in oil reservoir and fill if needed. See Operation and Maintenance Manual.

2. Start the engine and keep it at low idle.

3. Put pressure on the brake pedal and open bleed screw (1) to let air out of the system. Close bleed screw (1), while pressure is still on the brake pedal, then let the pedal return to the original position.

4. Do Step 3 again as many times as necessary until the brake liquid is free of air.

5. Use the procedure in Steps 3 and 4 again, except this time use the left bleed screw (not shown).

6. Check the hydraulic oil level again and fill as required. See Operation and Maintenance Manual.

Parking Brake Test

⚠ WARNING

To prevent personal injury, the operator must be ready to use the service brake if the parking brake is not adjusted correctly and the lift truck starts to move.

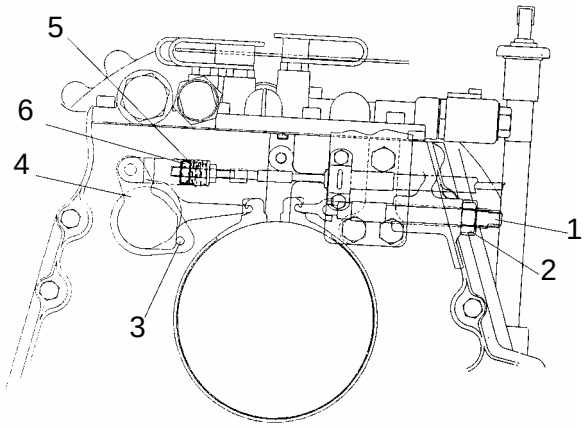
1. Drive the fully loaded lift truck forward up a 15% incline.

2. Half way up the incline, stop the lift truck with the service brakes. Make an application of the parking brake.

3. If the parking brake has the correct adjustment, the lift truck will be held in this position.

4. If the parking brake does not hold, do the steps in Parking Brake Adjustment.

Parking Brake Adjustment



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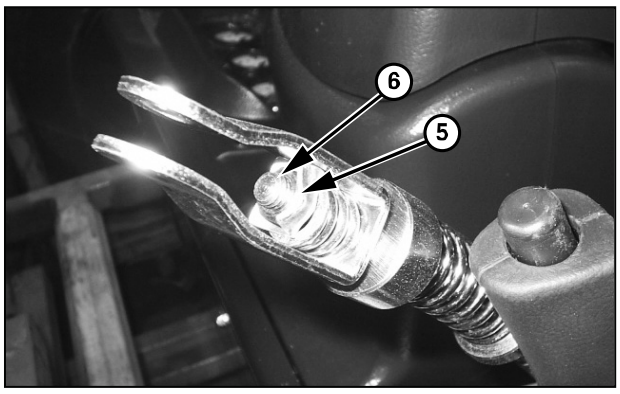
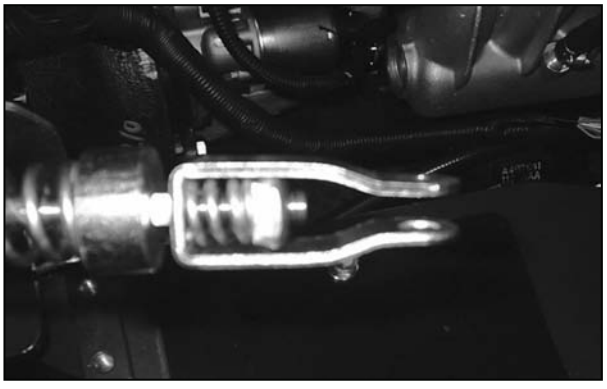
Parking Brake Adjustment
(1) Screw. (2) Nut. (3) Stop. (4) Lever. (5) Lock. (6) Nut

< Old cable with locking plate >



< New cable with locking block >



NOTICE

Turn the adjustment screw clockwise to tighten. Turning the screw too far counterclockwise could allow parts to fall into the bottom of the transmission. The transmission would then require disassembly to remove the parts.

1. Put the parking brake control in the released position.

2. Make sure lever (4) is against stop (3). If against stop, go to Step 5. If not against stop, go to Step 3.

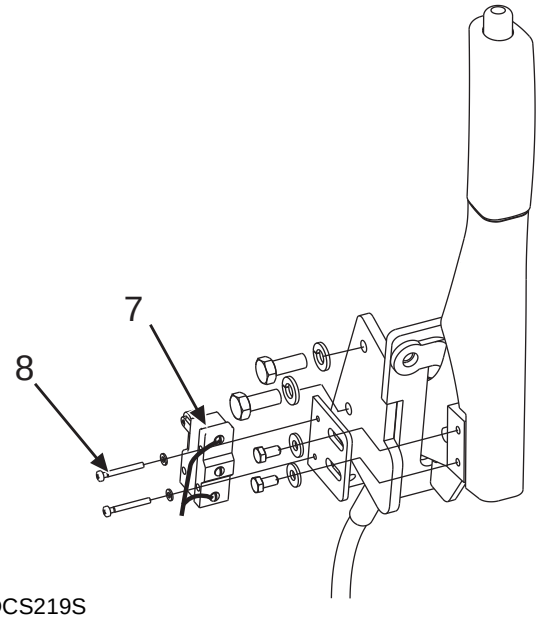
3. In case of the old cable with locking plate, bend lock (5) away from nut (6). Loosen nut (6) until lever (4) is against stop (3).
In case of the new cable with locking block, the function of the lock and the nut is combined to the block. So, there is nothing to be bent.

4. Tighten nut (6) finger tight and bend lock (5) to hold in place. Be sure to do this correctly.⚠

5. Loosen nut (2).

6. Tighten screw (1) to a torque of 5.6 to 6.8 N·m (50 to 60 lb·in).

7. Loosen screw (1) 1.2 to 1.5 turns, hold in this position and tighten nut (2).



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Parking Brake Adjustment
(7) Switch Assembly. (8) Screws.

8. Loosen screws (8).

9. Adjust switch assembly (7) until switch actuation occurs between the 2nd. or 3rd. click as the parking brake is engaged. Tighten screws (8).